Conference Proceedings: Higher Education and Research for Agriculture and Food Systems in the 21st Century

Global Consortium of Higher Education and Research for Agriculture

July 12–14, 2001

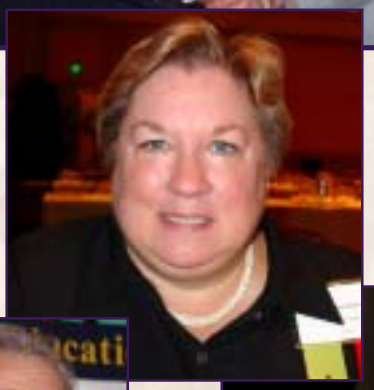
San Francisco, California, USA







for Agric







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Global Consortium of Higher Education and Research for Agriculture (GCHERA)

Higher Education and Research for Agriculture and Food Systems in the 21st Century

July 12-14, 2001

Conference Themes

New Science in a New Century: Agricultural Research, Life Sciences, and Information Technology

The Changing Nature of Food Systems and the University Response

Agricultural Curricula for the 21st Century

Organizing the University of the Future

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The Global Consortium of Higher Education and Research for Agriculture thanks the many individuals who worked to make the conference and this book successful, including: Lowell Hardin, Sally Ashlock, Janet Schwanke, and David Sammons, International Programs in Agriculture, Purdue, (for planning, administrative support, and communication); Ruth Ann Bowles and Sherry Swank, Printing Services, Purdue, (for registration material production); J. Brandon Ray, Printing Services, Purdue, (for registration packet design); David Acker, Global Agriculture Programs, Iowa State University, (for fund raising, financial oversight, and administrative support); Deb Schmidt, Iowa State University, (for database management); Steve Cain, Beth Forbes, Agricultural Communication, Purdue, (for media coverage); Jane Wolf Brown, Agricultural Communication, Purdue, (for Proceedings managing editor); Carol Bloom, Bloom Inc., Lafayette, Indiana, (for copy editor); Marian Sipes, Agricultural Communication, Purdue, (for transcription); Russ Merzdorf, Agricultural Communication, Purdue, (for Proceedings illustration and design); Haywood Publishing, Lafayette, Indiana, (for printing GCHERA cover); Printing Services, Purdue, (for printing GCHERA Proceedings content); and Vivian Scott, Purdue, (accounting).

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Foreward

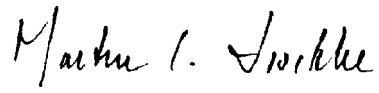
Dear Conference Participants and Consortium Members:

I am pleased to present you with a copy of the "Proceedings" of the 2001 conference of the Global Consortium of Higher Education and Research for Agriculture (GCHERA), which met in San Francisco July 12-14, 2001. Those of you who attended know what an extraordinary event it was and will enjoy reading this document to recapture parts of that meeting. Others with an interest in global agriculture, higher education, and research will find essential elements of this event collected in the pages that follow. I commend this to you as an important book documenting this major international conference.

The 2001 conference, which followed the founding global conference in Amsterdam in 1999, attracted over 200 educators and research scientists from 50 countries around the world. Representatives from agricultural institutions on every populated continent on Earth were present, reflecting the health and vitality of GCHERA, an organization that has now grown to nearly 400 members from more than 130 countries. If you are not already a member of GCHERA, I encourage you to join us in our most important work.

The conference participants heard from prominent leaders on a variety of subjects addressing the conference theme: "Higher Education and Research for Agriculture and Food Systems in the 21st Century." The presenters were grouped under four major sub-themes: New Science in a New Century; The Changing Nature of Food Systems and the University Response; Agricultural Curricula for the 21st Century; Organizing the University of the Future. The papers included in this book record the presentations of these speakers grouped under each sub-theme. In addition, the papers include my opening comments and summary remarks as well as the vision for the future of GCHERA presented by our new President, Rector Dmytro Melnychuk of the National Agricultural University of Ukraine. In addition, the conference was enriched by a poster session and a series of workshops, which are detailed in the "Proceedings."

As the motto on the conference registration packet stated, the purpose of this conference was to "Bring the World Agricultural Higher Education and Research Community Together to Meet Global Challenges." We have made important strides forward but we still have much to do. I invite you to join us.



Martin C. Jischke

Past President, Global Consortium of
Higher Education and Research for Agriculture
President, Purdue University

The Mission at Hand: Food Security and Environmental Integrity

Martin C. Jischke

President, Global Consortium of Higher Education and Research for Agriculture

President, Purdue University

Indiana, USA

What truly exciting times in agriculture! Today's science and technology have never equipped humankind better for improving lives the world over. Yet, we face enormous challenges in agriculture and in agricultural education in this new century.

We must explore ways to feed a growing world population and simultaneously reduce the environmental impact of food production. We believe food security and environmental integrity must go hand in hand, and we must address them globally with all stakeholders participating, each bringing his or her own expertise to the discussion.

That is the mission of the Global Consortium of Higher Education and Research for Agriculture (GCHERA). This consortium is the result of bringing leaders of the world's agricultural higher education and research communities to Amsterdam in 1999. Since that year, we have been hard at work continuing the progress that began there.

Food Security and Environmental Integrity

In this world today, we simply cannot afford to ignore the global imperative in all that we do in agriculture. All of us face many of the same issues, particularly those of us from institutions, universities, and research institutes where agriculture is a recognized curricular strength and an honored academic tradition.

Agriculture is unmistakably changing and ever-globalizing. The science and technology that underlie agriculture are undergoing a revolution, which leads our institutions to analyze and debate environmental issues implicit in the food production systems employed around the world.

The two critical charges we must accept in meeting the challenges of feeding the world's population, while simultaneously reducing environmental pollution, are educating highly qualified professionals and researching to develop new understandings and solve important problems. Applying science and technology wisely is essential to solving the world's food problems.

The Work of GCHERA

GCHERA's executive committee members have made significant strides during the past two years in expanding the network of institutions of higher education and research that comprise our global consortium. One of the most important accomplishments is the International Higher Education Loan Program, or I-HELP. This program helps young professionals with interest in food security and environmental sustainability gain valuable experiences. It also provides them with an opportunity to improve and strengthen their leadership skills. I-HELP Fellows receive a $5,000 loan for support of program expenses. If Fellows return home and implement some of their new knowledge and skills, GCHERA may forgive up to 50 percent of each loan. This year the program selected and supported 20 Fellows.

Dr. Dmytro Melnychuk will lead GCHERA's efforts as its new president. Dr. Melnychuk is the rector of the National Agricultural University in Kiev, Ukraine. His leadership and scholarly pursuits make him one of the most qualified people in the world to lead the work of this growing organization.

Today, some 388 members from more than 130 countries make up this consortium. In attendance at this 2001 meeting are educators and researchers from 50 nations and more than 150 universities, along with representatives from agricultural institutions on every populated continent on Earth.

The theme of the 2001 conference, "Higher Education and Research for Agriculture and Food Systems in the 21st Century," was organized around several subthemes:

- New science in a new century;
- The changing nature of food systems and the university response;
- Agricultural curricula in the 21st century;
- Organizing the university of the future.

Our conference attendees are an extraordinary group of global leaders in agricultural higher education and research. Perhaps nowhere in the world has there been a collection of people more capable of accomplishing our goals of food security and environmental stewardship. It's only by working together and sharing problems, ideas, and information that we will reach our critical goals.

My hope is that each of us, as a result of attending this conference, will become a changed person—changed because we will leave with new knowledge, new insights, new understanding, new energy, new cohesiveness, and new connections to meet these challenges in agricultural higher education and research. My measure of success for the 2001 GCHERA conference is what we each accomplish after the conference. It is up to each one of us. We truly can be the builders of a new world.

We are grateful to all the sponsoring organizations, including the Farm Foundation; The Food and Agriculture Organization of the United Nations; Iowa State University; the John Deere Foundation; Pioneer Hi-Bred International and Dupont; Purdue University; United States Agency for International Development; United States Department of Agriculture, Cooperative States Research, Education and Extension Service; University of California, Davis; the W. K. Kellogg Foundation; and Dow AgroSciences.

California Agriculture, U.S. Higher Education, and the Global Food System

William B. Lacy
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How appropriate that the Global Consortium of Higher Education and Research for Agriculture is meeting in California. This state's agriculture is among the world's most productive and efficient. With more than $27 billion in farm and timber value in 1999, California is the top agricultural state in the United States, a position it has held for more than fifty years.

Agriculture in California

California's moderate, Mediterranean climate, fertile soil, diverse land resources, and excellent research and education system allow year-round production of more than 250 commodities, ranging from alfalfa hay to wine grapes. California farmers and ranchers lead the nation in 77 commodities and produce all the nation's commercially grown almonds, artichokes, dates, figs, kiwi fruit, olives, persimmons, pistachios, pomegranates, prunes, raisins, and walnuts. Remarkably, California farmers grow more than 50 percent of the nation's fruits, nuts, and vegetables. While the state is known for its array of unique specialty crops, its leading performers in terms of gross sales are dairy products ($4.3 billion), grapes ($2.4 billion), nursery products ($1.8 billion), cattle and calves ($1.2 billion), and lettuce ($1.1 billion) (California Farm Bureau Federation [CFBF] 2001).

With 75,000 farms, California has only one third the number of farms as the leading state, Texas, but more than double Texas's farmgate and timber value. Contrary to popular opinion, not all farms in California are megafarms, although it does have some of the very largest in the world. However, the average farm size is 374 acres, about 50 acres below the national average. Indeed, 88 percent of all farms in California have fewer than 500 acres, and 60 percent have fewer than 50 acres. This relatively small number of diverse farms is estimated to create 1.4 million jobs (CFBF 2001).

Farm Markets

Because of its proximity to important markets in the Pacific Rim and its reputation as a supplier of high-quality food, fiber, and forest products, California has also become the nation's number-one farm export state. California exports about 20 percent of its total agricultural production with almonds, cotton, wine, oranges, and milk its top exported commodities. Japan, Canada, South Korea, Hong Kong, and the United Kingdom are the top export markets, totaling more than $3 billion in 1998 (CFBF 2001).

Water Supplies

Water is critical to California's agricultural success and survival with more than eight million acres in irrigated acreage. Research has enabled farmers to stretch water supplies by using progressive water management programs and the most advanced irrigation technology, i.e., lasers to level farmland, computerized irrigation management, soil testing, and an array of irrigation systems and equipment. In 1995, while increasing production by 67 percent, California farmers used slightly less water than they did in 1967 (CFBF 2001).

Farm Crisis on the Horizon?

A dark side to this picture, unfortunately, exists as well. Much of California's agricultural success has been built on capital-, energy-, and research-intensive, irrigated monocultures that global markets increasingly influence. This year the California Farm Bureau Federation formed a Farm Crisis Task Force to address such areas of concern as taxes, energy, water, environmental regulations, retail concentration, international trade, agricultural chemicals, labor, and public awareness. A University of California, Davis (UC Davis) professor Steve Blank (1998) pointed out that, while highly productive, California continues to slowly shrink, with farm acreage down four percent from

1992 to 1997 and 3,500 fewer farms during the same period (U.S. Department of Agriculture [USDA] 1999).

For an increasing number of commodities in California and the United States, profits are squeezed because costs, which are local, increase and market prices, which are global, are relatively stable or trending down in real terms (Blank 1998). The price trends are due to increases in total supplies made possible in part by research and technological developments and international trade agreements, i.e., General Agreement on Tariffs and Trade (GATT) and the North American Free Trade Agreement (NAFTA). Between 1990 and 2000, the USDA's index of average prices received by farmers in the United States decreased seven percent (National Agricultural Statistics Service [NASS] 2000). At the same time, local input costs are rising across the nation and, in particular, in California. For example, California's average value per acre of farm real estate has increased steadily since the mid-1980s, reaching $2,610 per acre in 1998 compared to $593 per acre in Texas (NASS 1999). Labor costs are also rising with total wage rates paid by farmers increasing 40 percent from 1990 to 2000 (Economic Research Service [ERS] 2000).

Efforts to improve the profit margin for various commodities have addressed both prices and costs. Most efforts to improve prices have not been successful so most farmers have turned to costs. Here, the most successful strategies include reducing cost per unit by (1) increasing the size of operations and (2) introducing new technologies. Both have helped slow the cost squeeze but not reverse it.

Blank (2000) noted that U.S. farmers have been squeezed out of one commodity after another, moving up through what he calls the four general categories of the farming food chain. Low-revenue annual crops, including many field crops, such as wheat and corn, are replaced by higher revenue crops such as low-value perennials (i.e., alfalfa), then by high-value annuals (fruits and vegetables), and finally by high-value perennials (tree and vine crops). For example, between 1992 and 1997 in California, despite the decrease in total farming acreage, acres in vegetables increased from 1,016,744 to 1,209,259 and acres in tree and vine crops increased from 2,245,781 to 2,582,084 (USDA 1997). However, each of these moves required more money per acre, and those investments were less flexible, resulting in higher risks. While these shifts have resulted in increased revenues, profit margins have not increased nor are they expected to as global competition increases. For the past 30 years, agriculture's gross profit margin has been two to three percent (ERS 2000). The challenges are diverse and formidable. However, research and education from our institutions of higher education both in this country and around the world must be at the center of any strategies for dealing with this wide range of issues facing our food system, environmental sustainability, and rural community viability.

U.S. Higher Education

It is equally appropriate that Purdue University with cooperation from UC Davis and Iowa State University has provided leadership for a conference of this consortium whose mission remains fostering global cooperation for the improvement of higher education and research for agriculture. The generation and dissemination of knowledge are critical components for solving the food security and environmental problems confronting our world. These three institutions, along with other key land-grant universities, are among the finest public educational institutions in the country. They are also part of the best public higher education systems in the United States—the University of California, the Big Ten Conference, and the Big Twelve Conference. These same institutions have strong and leading agricultural colleges, which continue to play prominent roles toward their reputations for excellence in research and education. In the recent rankings by *U.S. News and World Report* (U.S. News Online 2000) of the top national public universities, all three were among the top 40 campuses: UC Davis (10), Purdue University (20), and Iowa State (38). In addition, six out of the top 15 national public universities were University of California campuses, while eight of the top 25 were Big Ten institutions, and five of the top 50 were in the Big Twelve Conference.

In agriculture, the dominance is even greater. In a recent study by the publishers of the *Science Citation Index* (Dateline 1998) agricultural science papers published by UC Davis researchers were referenced in other scientific journal articles more often than papers from any other research institution in the nation. Seven Big Ten institutions, Cornell University, and Iowa State University, completed the list of the nation's ten most cited research institutions in agricultural sciences. Much of this leadership and excellence has been built on strong international research collaboration and education. The future will depend even more critically on fostering global cooperation for the improvement of higher education and research for agriculture.

It is also important and appropriate that this international global conference is meeting here in California, one of the most diverse and globally oriented states in population and cultures, and that UC Davis, one of the most diverse campuses in the country, serves as cohost. One in four Californians are foreign born, and it is estimated that by 2005 that ratio will increase to one in three. A look at the diversity of K-12 students in California shows 40 percent are Hispanic, another 40 percent are white, 11 percent are Asian Pacific Islanders, and slightly less than 9 percent are African Americans. At UC Davis, I am fond of saying to our more than 1,000 international students who arrive on campus each year that everyone should feel at home because everyone is a minority. A little more than 40 percent of our student body is of European descent, approximately one third is of Asian descent, and roughly, 10 percent is of Latino descent. Diversity of perspective, values, and experience will be increasingly important in the generation, dissemination, and application of knowledge for our global food system.

Global Food System Goals

In conclusion, the agenda for higher education and research for food and agriculture must be broad based and diverse, and we must address multiple goals that may appear contradictory, but which we must approach as complementary. Specifically, I refer to the complementary goals of food security, environmental sustainability, empowered and just communities, poverty alleviation, and democratized science. Achieving all simultaneously cannot be taken for granted, particularly in the short term. For example, as hundreds of millions of people try to eke out an adequate food supply from already depleted soils, degraded hillsides, tropical rain forests, and dry areas threatened by desertification, their efforts further harm the environment, thereby worsening their poverty. While opportunities for progress on these goals depend considerably on specific social, economic, and agroecological circumstances, much more remains for us to learn about how these critical and interrelated goals are linked and the factors that condition these relationships (Lacy, Lacy, and Hansen, in press). Indeed, Richard Manning (2000) documented, through accounts in Ethiopia, Zimbabwe, Uganda, India, China, Chile, Brazil, Mexico, and Peru, that improvements in the food, environment, and poverty triangle seem most likely to come from the developing world, when alternative methods and philosophies, based on indigenous knowledge and native crops, as well as cutting-edge technology, are all considered.

Ultimately these goals are inextricably linked, and successful pursuit of them will require the best our institutions of higher education have to offer, coupled with actions by other related institutions and appropriate government policies. Finally, this agenda must involve aggressive and creative global collaborative efforts at the same time that action is grounded in the community. Communities continue to be the basic building blocks and foundations of our society, making critical contributions to the quality of food systems, environment, education, health, economy, and overall well-being.

It has been said that the future belongs to those who believe in the beauty of their dreams. However, the leaders assembled at the 2001 GCHERA conference and our colleagues must do more than dream. We must provide the leadership and commitment to pursue solutions to these complex issues. We must be the change we wish to see.

Bibliography

Blank, S. C. 1998. *The end of agriculture in the American portfolio.* Westport, Conn.: Quorium Books.

Blank, S. C. 2000. "Is this California agriculture's last century?" *California Agriculture* 54(4): 23–25.

California Farm Bureau Federation. 2001. *Facts and stats about California agriculture.* www.cfbf.com/info/agfacts.

Dateline UC Davis. 1998. *College of Agricultural and Environmental Sciences tops citations list.* December 7: 2.

Economic Research Service. 2000. *Situation and outlook report.* Agricultural income and finance 74 Feb. Washington, D.C.: U. S. Department of Agriculture.

Lacy, W. B., L. R. Lacy, and D. Hansen, In press. "Global food security, environmental sustainability, and poverty alleviation: Complementary or contradictory goals?" In *Food security and environmental quality,* edited by R. Lal, D. Hansen, N. Uphoff, and S. Slack. Boca Raton, Fla.: CRC Press.

Manning, R. 2000. *Foods frontier: The next green revolution*. New York, N.Y.: North Point Press.

National Agricultural Statistics Service. 1999. *Agricultural land values: Final estimates, 1994–1998.* Statistical bulletin no. 957. Washington, D.C.: USDA Agricultural Statistics Board.

National Agricultural Statistics Service. 2000. *Agricultural prices.* Washington, D.C.: USDA Agricultural Statistics Board.

U.S. Department of Agriculture. 1999. *1997 census of agriculture.* www.nass.usda.gov/census.

US News Online. 2000. *2001 college rankings: Top national public universities.* www.usnews.com/usnews/edu/college/rankings/natu_pub.

Globalization and the Contemporary University

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Globalization—a world more closely tied together, a world where events occurring in one place are more likely to have an impact (and a faster impact) in another part of the globe. Globalization is driven by the increased speed and lower costs of moving money, information, goods and people. It is also driven by new information technology, more open trade, the spread of democracy, the end of the cold war, and strong market forces. Dramatic advances in science and technology have been underlying drivers. Science both enables globalization and is fed by it.

Globalization can be reversed by catastrophic events coupled, perhaps, with huge policy changes. In the decades before World War I, globalization was on the rise. In fact, as a percentage of world GDP, international trade in 1910 was about the same percentage as it is today.

World War I slowed the progress. One of the great catastrophic events in world history, it brought about communism in Russia, which led to the Soviet Union, and eventually to the cold war. Many argue that The Great Depression was in part an aftermath of World War I, as was the rise of Hitler. Consequently, trade barriers went up, and international trade was restricted.

It was only after World War II that globalization and the integration of the world began to gain momentum again, with the United Nations' General Agreement on Tariffs and Trade (GATT), the founding of a number of new international institutions, and significant policy changes.

Globalization has shown us an array of advantages. It has brought significant economic growth in some parts of the world; it has helped advance individual freedom and democracy. In time, I believe, it will help us solve many long-entrenched problems.

One such problem is child labor. In developed countries, we now hear more about child labor problems as a result of the global economy, mass communication, and the Internet. With increasing pressure, we are likely to see significant child labor reform in a decade or so.

But globalization has also brought challenges. For example, world markets, financial markets, and economies are much more sensitive to one another. The first day the market fell in 1987, I was Acting Secretary of the U.S. Treasury, and it wasn't a good day to be in that position. For the first time, the public saw clearly how interdependent the world financial markets had become. We continue to see this in financial markets today.

There are also problems associated with people and geographic areas that lose ground, hopefully only temporarily, because of economic shifts that come with globalization. Certainly, people sometimes fall further behind as a result of international economic shifts. Creating opportunity for people with few skills is a major issue.

Furthermore, although the world press is an advantage in improving communication worldwide, it is also perfectly capable of spreading global misinformation.

Whatever our view of the advantages and disadvantages, however, I don't think that we really have much choice but to work for globalization. It makes sense, then, to have a conference focusing on the key area of agriculture in an international context.

I hope a hundred years from now historians will look at this period and say that the faster trade, communication, and technology of this era greatly integrated the world and that science enabled greater globalization. I also hope they will be able to say that this era was the beginning of a renaissance of well-being for people throughout the world.

Our primary question today is—What is the role that universities with agricultural colleges should play to bring about that renaissance?

Many of the world's universities have very common issues they must address and similar problems they

must solve. But for organizational purposes, I first address universities in industrialized nations, and then those in developing nations.

Universities in Developed Countries

Agriculture colleges in developed countries are becoming colleges of biology and life sciences, rather than agriculture colleges as traditionally defined. We should encourage this pattern to continue and encourage stronger relationships with the social sciences as well.

We need to have a more broadly defined mission for agricultural colleges in order to address today's issues and to sustain public support. There are major implications for such a broader definition of our agricultural mission.

Agricultural Curriculum

In curriculum, for example, the impact is substantial. Today we know that our graduates who return home to farm, in most cases, return to very different farms than we knew when we were students. I grew up on a farm in western Michigan where my father milked 50 cows. Now, most such small farms are gone. Today, a few miles from my father's farm there are two farms, each with 2,000 cows. Today, most students in our agriculture colleges don't go back to single-family farms. Those who go into farming usually go to large farms while others enter careers in agribusiness or agroindustry.

Today's agriculture-related careers require that we train students differently than in years past. Our students need more management and business skills and a broader technical and science foundation, as well as specific job knowledge.

Globalization means international experience should also be an important component in the education of today's students, including agriculture students. Michigan State University (MSU) probably has the largest study abroad program of any U.S. university, and we expect to grow in the years ahead.

Instruction must change as well. We should be delivering more Web courses. At MSU we had about 4000 enrollments in Web-based courses in the last twelve months. We have also begun pairing our professors with professors in other countries to team-teach distance learning courses.

In short, the curriculum for our College of Agriculture at Michigan State University and around the world is changing and will continue to change to meet new needs.

Research in Agriculture

Dramatic changes are also occurring in agricultural research on our campuses in developed countries, and even more change needs to occur. We now focus on issues that were not high on our agenda a generation or two ago. One key set of issues, of course, involves the environment and sustainable agriculture. What do you do with the waste of that farm with 2,000 cows? What about the ground water? And it goes beyond that. Some MSU professors think—and a number of people are working at this—that proper tillage and fall coverage may be a significant contributor to reducing global warming. We haven't quantified the impact yet, but such research has real potential.

MSU, and other universities and institutions are also working with Dow Chemical to see how biotechnology research can identify ways to use plants as substitutes for petroleum to make certain materials.

Of course, issues such as how to grow plants requiring less fertilizer and pesticides remain important research problems. In addition, there are issues such as how to use microbes to clean up soil and water.

Animal diseases and animal to human diseases are prominent research areas as well. Mad Cow disease has everyone's attention. Michigan currently has a problem of tuberculosis (TB) in their deer herds that has spread to cattle in some limited areas. There isn't much likelihood, we think, that bovine TB will be transmitted to humans; however, the state of Michigan just last year provided $57 million for MSU to build a new animal disease diagnostic center. Colleges of agriculture, veterinary medicine, and human medicine are finding many areas where they need to work together.

The new colleges of agriculture may well be central to finding solutions to food safety; and at MSU and other universities, this is a major area of focus.

In brief, there is a whole set of issues that a generation ago might not have been at the core of agricultural research. Today these matters are central to the research agendas at many agriculture colleges. We need to drive our research further in these and other new directions.

Under Peter McGrath's leadership of NASULGC, a

group of university leaders is working with our funding agencies—U.S. Department of Agriculture, National Science Foundation and others—to develop programs in which universities and funding agencies work together on the related problems of food, health, agriculture, and environment.

Of course, such research and its applications are forms of outreach. That engagement is in the tradition of U.S. land-grant universities, and it must continue.

I think that in a decade or so we're going to look back and see that our large universities made major contributions to this broadly defined set of old and new issues.

Land Use

In developed countries we have still another set of problems. In many places, our agricultural land is disappearing. For example, in southeast Michigan—greater Detroit—the largest urban center in Michigan, over a twenty-year period population only went up some, but the developed land increased by much more. In many areas of the United States, land development is outpacing population growth.

This is an issue where urbanites, suburbanites, and rural people should be able to come together. In general, the urbanites and suburbanites don't want to see the farms disappear because many wish to have rural areas available. They view retaining rural areas as a quality of life issue. Many of us in the United States can certainly empathize with Europeans who would not want a France or an England without countryside. Clearly, the tourism industry does not want farms and rural areas to disappear either. In Michigan and many other states, farming continues to be a major economic factor, and we want it to remain so.

The heart of this issue is how to maintain a balance between competing needs. What land use rules or requirements do we need? Universities certainly have a role in addressing this difficult issue. Can we find an agriculture that produces more value from the land? This is necessary because, in time, land will be sold for non-agricultural use if value for that use is much greater than for agriculture. Solving our land use problems is a policy issue our colleges of agriculture must address and work with governments, business, and communities to resolve.

And another point concerning these public policy issues: It is obvious that science and technology are major drivers as we work on the many problems faced by society. But many science and technology issues are very controversial, and universities need to maintain their unbiased role in the arbitration of facts. That is not going to be easy in the years ahead. How do we colleges of agriculture maintain the broad public trust that we've enjoyed over the generations? In Michigan, and I'm happy to say it's still true, when Michigan State makes a statement, the public generally reacts by saying, "Yes, that's probably right." There is a heavy presumption in our favor. But as universities such as MSU receive more and more funding from the private sector, can we continue to maintain the disinterested scientific stance that sustains the public trust?

We are just starting to deal with this set of issues in U.S. universities. We may well need independent panels of observers within our universities or some other approach to safeguard scientific independence. I am not sure just how to do that, but I think over the next few years we will come up with a range of models because we cannot afford to lose public credibility. The public needs to have a disinterested scientific perspective in a world where science is more and more important in our daily lives.

Universities in Developing Countries—Africa

Let me turn now to developing countries and their agricultural colleges. While we should not overlook the major issues in parts of Latin America and Asia, I would like to focus on Africa because it represents the biggest single concentrated set of development problems that we have in the world.

Two-thirds of the population of Africa remains rural. Per capita food production, however, is no greater today than it was in 1970. Evidence is now clear that where an area has such concentration of farmers and rural people, there is almost no historical example where there has been a significant increase in people's income without increasing food production. Representatives here from China would agree that China would not be where it is today if there hadn't been a huge increase in China's food production over the last 20 years.

Studies by IFPRI and others confirm that increasing food production has a major multiplier impact. What happens is that when a farmer in Kenya produces more, the farmer and his or her family will eat some of it, and some of it will be sold. The money earned will be used to buy other things, increasing nonfarm rural income as well. This multiplier impact has been well

documented. With regular increases of production over ten to twenty years, you can significantly increase total income for rural areas. We are not talking only about more income just for the farmer; we are talking about increased farm and rural income for a whole country.

The International Donor Community

Despite this evidence, over the last few years the international donor community has very substantially decreased support for agriculture and food production. In the last 12 or 13 years, AID's support for agriculture has dropped by about two-thirds. For the total bilateral donor community, including the United States, the support for agriculture has dropped about 50 percent. The World Bank support for agriculture has decreased by 75 percent, and the Bank's internal projections show that, in fact, such support will go down even further. These trends are alarming.

Why has this occurred? In my view, one reason is that there is an urban bias among donors. Urbanites are the people that you tend to talk to when you talk to a country. It is in urban areas that there is capacity to demonstrate, to turn over governments; that's where the college students are. Another reason is that in Africa we've focused more on disasters in the last 10 to 15 years than on increasing growth and income. We will need to continue to deal with disasters, of course, but we cannot expect long-term improvements without growth and income.

We need to get back on track regarding support for food production. I sense at least some movement by Africans, and others, in reversing the pattern. The President of Mali, the President of Ghana, and others were at a conference in Washington recently that a number of us put together where we strongly advocated for the importance of support for food production in Africa. In fact, I know that the President of Mali made a point on this matter when he and other African leadership met with President Bush. The U.S. Administration was receptive. I think we are seeing some movement.

International Partnerships

We also need to consider what we could do with additional resources for agriculture and rural income. I think universities in developed countries can and should be at the very heart of this matter. Developed country universities need to have long-term partnerships with African universities and countries. Such relationships, which the United States encouraged extensively from the 60's through the 80's, paid off in many cases. The relationships don't need to cost a great deal, but they need to be long-term. With a long-term relationship there develops a mutual capacity, an interest, and knowledge about a particular country and universities and institutions in that country. Such relationships have proven to be very productive in policy change, education, and research.

Such relationships offer enormous educational opportunities. In the past we were more likely to think about bringing students back to the United States or to Europe, and certainly some of developed country training needs to be done here; however, with Web-based technology we can often do more and do so at less cost. Some of this will be educating the educators. Professors in developing country universities could help teach more developed country students using the Web. More than ever, relationships can be two-way streets.

Close, long-term research relationships with universities in developing countries are important too. Because of the technology, it is becoming much easier to exchange information. I remember at AID when we wanted to increase the production of sorghum in the Sudan for example, we worried about where to place the people for this major project. Should we place them back at a major university in the United States, or should we have them in Sudan? Today that may be an easier decision or at least a different decision. There is greater possibility that the African-based professor can be in close touch with the United States based knowledge and people. Obviously what we need and should get is people from both developed and developing country institutions to have access to new knowledge in real time and, of course, access to each other. That is how you have the capacity to really work together on problems.

It is tempting to say that Africa needs a green revolution. No doubt that will be required, but it will be a different revolution than the last one. Africa has such a range of soils, climates, and crops. We need to increase production of some subsistence crops like yams, millets, and sorghum, but we also need greater production of crops which can be exported and/or sold beyond the farmer's own community.

Biotechnology is absolutely central to achieving results in the time required. The Nigerian ambassador to the United States had an op-ed article in *The Washington Post* a few months ago, which had significant impact in Washington. He said, in effect, "It's

fine for you in the United States and Europe to be critical about biotechnology, but your people aren't starving." We've got to have the tools of biotechnology to move forward. Speed is critical and biotechnology can really help. We are learning how to adequately regulate biotechnology research and products. When you look at the fact that agriculture production per capita in Africa is no more than it was 30 years ago, we certainly have some problems. Biotechnology is a central tool in remedying this situation.

Let's look at information technology problems faced by the universities in developing countries. I was at a conference not long ago where the Aga Kahn suggested that we need a global digital library. I can see donors, particularly The World Bank and some others, working to achieve that library. I think that an individual scientist in Kenya, Uganda, or Mali should have the capacity to link into the global intellectual community. We don't have enough of that capacity today, although more and more computer linkages are becoming accessible. But even if you have the linkages, professional journals are not generally available.

Here's what happens in the United States, and it impacts Africa. The Federal Government funds Purdue, Michigan State, or Cal-Davis, and these universities put in some resources, and their scientists do the research. To publish their findings, researchers have to sign away their copyright to a publishing company, which then sells the journal through subscription back to the universities at rate increases much greater than inflation. The publishing companies also sell the journal to the rest of the world at these rates. The problem is that there really isn't a capacity in much of sub-Saharan Africa to buy journals at such prices. Some progress is being made, and NIH has worked at this. Recently some medical journals agreed to reduce their rates. But I keep thinking some group of federal government agencies is going to say, "If you get our grant, professor and university, you can't give away the copyright to developing countries, and the journal in which you publish will also be expected to have the article available on the Web for developing countries.

I often feel a little sad when I shake the hands of new doctoral graduates from many parts of Africa who are going back to Africa or another developing area. Too often, within a very few years, they are no longer on the cutting edge of their field because they lack access to the latest information. Something needs to be done.

I think that we are at an important moment in history. It's not an irreversible moment, as it was during World War I. However, I think it is expected that globalization will continue to speed up under the impetus of science and other forces.

Agricultural colleges, as we are beginning to redefine ourselves, have a significant role in both industrialized and developing countries. If we work together, we can contribute greatly to a renaissance of well being for people around the world.

Bringing Change and New Science to the Developing World

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About three decades ago, the world faced a global food shortage that experts predicted would lead to catastrophic famines. The Green Revolution, however, held famine at bay. Scientists found ways to increase yields of some of the world's most important cereal crops, such as rice and wheat, and farmers in the developing world implemented the innovations with success. In contrast, the challenge confronting today's world is that simply increasing cereal productivity may not have the impact it did thirty years ago.

New Global Challenges

World human population currently is growing by about 100 million people each year, a global rate of increase of about 1.7 percent from our current population of over six billion. This means, at the very least, the world's farmers must increase food production 50 percent to feed some two billion more people by 2020, and maybe as much as 100 percent if current trends in meat consumption increase. These stark numbers have led some food policy analysts to call for a new and greener revolution that will again increase productivity and boost production.

But feeding the world in the 21st century will require not only food availability but food security; i.e., access to the food a person requires to lead a healthy and productive life. For specific populations, it means a person's ability to grow and purchase food, as needed. Food security focuses attention on areas such as income, which must be sufficient to purchase food; markets, which must be competitive to keep prices low; and natural resources, which we must conserve to ensure sustainable, long-term productivity.

Regrettably, the statistics on food security are grim. The Food and Agriculture Organization estimated as many as 840 million people currently do not have enough food to eat. About 20 percent of the people living in the developing world do not get enough calories, enough protein, or both. The companion problem of micronutrient deficiencies affects even more people in the developing world, particularly children and pregnant women. An estimated two billion lack sufficient iron in their diets, with about 1.2 billion weakened by iron-deficiency anemia. Vitamin A deficiency affects about 125 million children and has produced irreversible eye damage in an estimated 14 million. Hunger of this dimension traditionally has been among the rural poor who could not grow enough food to meet their needs. Now it has spread to growing numbers of the urban poor who cannot afford the food they need. Often food is available but not accessible. Throughout the developing world, hunger is linked to poverty.

Poverty in the developing world has many roots, including political and social discrimination. But many are poor because they have no tangible assets, no land, no livestock, no formal education, and few, if any, technical skills. Many either settled where the land is only marginally productive at best or where governments have failed to provide the basic infrastructure essential to economic development. Others migrated to urban areas.

Yet, the issue of food and agriculture does not end here. Increases in the productivity of food crops are peaking, even on lands where the Green Revolution was most successful. Irrigation and fertilization have reached their effective limits; the ability of cereal breeders to develop higher-yielding varieties has reached a plateau. With this situation, the environment has assumed a new importance.

Many of the most promising lands are already under cultivation, erosion is taking a growing toll, water shortages loom in many areas, and the majority of the world's natural resources, such as forests, grazing lands, fisheries, and wildlife, are overexploited. The loss of forests means more than the loss of trees. Agroforests protect watersheds, prevent erosion, minimize the impact of floods and drought, and stabilize local climates. Perhaps, most importantly, disappearing agroforests threaten the world's biodiversity, which is essential to the future food supply. For several major environmental problems, agriculture seems to be both culprit and victim.

Meeting these new challenges has become even more difficult because so few leaders acknowledge that the world faces urgent food and other agricultural problems. Sharp declines in public spending for agricultural education and research over the past two decades demonstrate their lack of concern. As pressures increase to expand agricultural production and, at the same time, conserve natural resources through wise use and management, leaders cannot ignore the crucial role of public policy nor the need for education, which must support the process that leads to effective policy making.

Now in the new millennium, the world community must overcome new challenges, including poverty, food insecurity, environmental degradation, and genetic resource preservation. Only if educators, researchers, extension agents, producers, and decision makers have the will to combine their knowledge, skills, and experiences can the world undertake such diverse and serious issues.

Effecting Change to Meet the Challenges

In retrospect, agriculture has been the cornerstone of development in many emerging industrialized countries in Asia. Developing countries could emulate this model. Currently, more than 70 percent of people in poor countries depend on the land for their livelihood. Yet, they cannot achieve agricultural growth today without employing methods that preserve the productivity of natural resources.

The science of agriculture is in the throes of massive change. Research is one key means by which the world increases and improves its knowledge of agriculture. Below are the important factors I recommend for making changes in agricultural research.

Biotechnology

For thousands of years, farmers have selectively bred crops and animals to improve output. In modern agriculture, the same strategy is in use. Scientists use this strategy at national agricultural research systems, universities, and international agricultural research centers (IARCs). Business and industry use this strategy in the private sector. Most selective breeding is aimed at enhancing production and increasing the ability of plants to resist disease and other environmental stresses.

Biotechnology has added new dimensions to agricultural research. For instance, tissue culture helps produce disease-free plants, which increases the developing world's productivity. As a case in point, the banana tissue culture work, developed in Taiwan for commercial production of healthy seedlings, has made it possible to boost the banana industry in Vietnam. Using molecular marker techniques has shortened the time and reduced the costs in developing new crop varieties, both in the laboratory and in the field. Another success in biotechnology is the identification of new DNA-based tools to diagnose plant diseases.

Biotechnology can change the makeup of plants in ways conventional breeders only dream about, such as allowing plants to grow in saline soils, remain untouched by weed-killing pesticides, or boost their nutritional content. The insertion of a gene that produces beta-carotene in a rice plant is another success story. Since rice is a staple in Asia as well as other regions, this genetically altered plant approaches Vitamin A deficiencies with a potential solution to irreversible eye damage, a major health problem. Researchers are also working to add genes to rice and vegetables to boost the iron content and help prevent iron-deficiency anemia.

Researchers see other gains with genes that confer resistance to insects or diseases, or that counter less-than-ideal growing conditions. Some developing world farmers are already sharing in the benefits of biotechnology. In China, for example, farmers with limited acreage are saving money and labor by growing transgenic cotton for bollworm resistance.

Scientists modify most genetically improved crop varieties only for a single trait, such as disease resistance or specific quality. The rapid progress they make in cutting-edge genomics may enhance plant breeding as they identify genes that are more functional. This may enable them to conduct more successful breeding for such complex traits as high temperature, flooding, drought, and salinity. Breeding for such traits has had limited success with conventional breeding, so these genomic advances would greatly benefit people in poverty who farm marginal lands.

Biotechnology cannot, however, make depleted lands more fertile or ensure water to irrigate crops. Meeting those two needs impels commodity-specific biotechnology research to embrace a broader vision. Such a vision includes sound management of natural resources, as well as productivity and profitability of smaller farming; promoting synergies among livestock, agroforestry, food and cash crop, aquaculture; integrated management of soil, water, and nutrients;

integrated pest management; attention to postharvest losses; and recognition of the socioeconomic realities of farmers.

On the other hand, because many breakthroughs in biotechnology are the products of proprietary science, development organizations have been concerned that significant advances will not be available to the poor in resolving their problems. Although scientific research is a long-term process with no guarantees of success, investors would not risk such sizeable sums unless they knew they could protect the intellectual property rights to any new discoveries. These rights are the only way they recoup their investments and make a profit. That protection is necessary to the success of this kind of research, but it raises the very real question of whether proprietary science will ever serve the public good.

Natural Resource Management

Most natural resources are renewable, but some are not. Scientists can study each resource independently—soils, water, rivers, coastal zones, forests, biodiversity—to understand its flows and cycles. But together, natural resources form a system that researchers must consider as a whole.

We in the agricultural sciences must change our thinking—from classical agronomy to ecological science and system dynamics; from factor-oriented management to integrated natural resource management. The agricultural researcher, therefore, must assess and study the combined stresses and replenishment capabilities of different ecosystems to achieve maximum productivity. This approach has helped IARCs in providing new varieties suited to conditions in a given ecosystem.

The challenges of natural resource management are systemwide, though the precise problems vary from region to region and from ecosystem to ecosystem. Water provides a good example. Unless fresh-water resources are properly managed everywhere, water shortages are likely to become the most severe constraint on world food production. Scientists have found that irrigation that is more efficient can meet about half the anticipated increase in water demand. Efficient irrigation can also ease problems caused by too much water, such as waterlogging and salinity. Scientists are also working to identify techniques for improving water management in regions already confronting shortages and for helping other areas to conserve and use water resources more effectively, averting future shortages.

Farmers/producers can adapt effective tools of resource management to meet local needs, with growing emphasis on precision farming and such strategies as integrated pest management and integrated nutrient supply systems, which protect the environment and help preserve the resource base. IARC research is showing how natural resource management can provide the foundation needed to achieve the goals of agricultural sustainability in the developing world. Today's advanced tools—e.g., geographic information systems, remote sensing, and global positioning systems—and methodologies for ecological analysis and computer-based modeling could facilitate approaches that are even more comprehensive.

Resource management research will also play an important role in helping poor farmers adapt to the consequences of ongoing climatic change and mitigate its deleterious effects. We must conduct research to develop technologies that not only help to promote the sustainable use of natural resources but also mitigate the impact of agriculture on climate. Although such development is critical to the agriculture sectors of developing countries, they may not have the scientific or institutional capacities to undertake the required research.

Information Technology

Information is an extraordinarily valuable resource for all aspects of agricultural research and development. It ranges from simple statements of fact or instructions for the practitioner, through a comparison of options for the policy maker, to a comprehensive set of detailed facts, figures, and contact points for the researcher. The recent convergence of computing technology and telecommunications is having an impact on all areas of agricultural research and development. We can transform the phenomenal growth of electronic networks in the past few years into a more interactive global agricultural research system. Unlike radio or television, the Internet facilitates two-way communication, making it possible to tap into and share the innovative talents and experiences of scientists and their partners in all parts of the world. Scientists can send vast amounts of knowledge anywhere quickly and cheaply, making available to the developing world the large databases, libraries, remote sensing, gene banks, and other sources that were once far too expensive or remote.

But modern information technology's impact is not just for information storage and databases, but for

focusing, organizing, and streamlining agricultural research. With appropriate information from stored databases, we can develop computer-based modeling. And among other things, the modeling will assist in agronomic decision making—to integrate crop and animal production and to predict the suitability of any specific crop, cropping sequence, or natural resource management in a given environment. Industrialized countries have already employed many of these models. Continuing work should focus on developing countries where researchers, scientists, and practitioners desire increased productivity and appropriate natural resource management and where they continue to wait for the necessary information.

Furthermore, the computer-based expert system has the most potential in delivering information and knowledge beyond the agricultural research community in industrialized countries and into the realm of partners in developing countries. Increasing numbers of initiatives use this kind of technology for the diagnosis and treatment of crop protection problems. Based on the encapsulated knowledge of experts in particular fields, this system provides powerful aids to the diagnosis of disease symptoms. It transfers knowledge directly to whoever needs it most. But communication between expert and partner can be a two-way process. Digitized image management allows the original to be faithfully reproduced at high resolution. In this case, for example, a partner can transmit an image of an unknown disease symptom to an expert for identification.

Advanced information technology provides also an unequaled potential as a training or educational aid to students and extension agents. Trainers can incorporate teaching or extension materials into a Web page, readily accessed by the user. They may also create interactive, multimedia learning centers and hot links to remote areas.

While the potential of using advanced information technology is undeniable and undoubtedly opens up new vistas for the transfer of scientific information, the costs for developing countries may still be high, but they are steadily reducing. The real significance of the microcomputer revolution is that computers directly deliver information and information processing systems to users, to a large extent bypassing the need for sophisticated information infrastructure, which does not exist in many developing countries, and is difficult to sustain where it does. Some scientific organizations have offered to the developing world special access to electronic scientific journals, a practice likely to spread because of its low cost. As these organizations release the world's scientific and technical literature, this new knowledge flows to developing and industrialized nations alike.

Integrating Universities

Many universities in developed countries predominate in public sector agricultural research and development. These universities provide a pool of well-trained scientists with substantial capacity for executing not only agricultural research and extension but also basic research of new sciences. Universities also train the next generation of high-caliber scientists.

On the other hand, one of the remarkable accomplishments of the Green Revolution was the establishment of a system of agricultural colleges and universities in tropical South Asia and Southeast Asia. Beginning in the late 1950s, universities from India to the Philippines were patterned in varying degrees after the U.S. land-grant model of teaching, research, and extension. Unfortunately, since the mid-1970s, attention to agricultural higher education and institution building in developing countries in Asia has diminished. Agricultural colleges and universities in developing countries are placed on the periphery of agricultural research and development; usually they have weak linkages with National Agricultural Research Institutes (NARI). They also face many problems that hinder their effectiveness as research and teaching institutions.

The basic strength of universities in industrialized countries is that their research and training functions are complementary to each other because research is an integral part of postgraduate education. Universities frequently have an institutional culture and a relatively autonomous status conducive to research. The greater flexibility in operating procedures and regulations in universities in developed countries may make it easier for university scientists to obtain funding and engage in collaborative research with other research institutes and funding entities. Indeed, in some countries, it may be most appropriate to place universities in the lead in executing research and to give them the status, responsibility, and funding usually associated with NARI. The move toward looking at research systems as a whole will inevitably elevate the role of universities in research. To better integrate universities into national agricultural research systems (NARS) in developing countries in tropical Asia, I recommend the following measures:

1. Shift more funding to competitive grants to tap university skills in research. To ensure NARS development, concentrate effort in establishing and supporting research in the university sector. Upgrading universities will be critical to improving the human resource capacity for scientific research in NARS;
2. Develop collaborative research programs, e.g., through a special fund, between NARI and universities;
3. Provide opportunities for staff exchanges, such as graduate students undertaking thesis research in the NARI and NARI scientists taking sabbatical leaves in universities; and
4. Channel more donor support for foreign postgraduate training to develop local university capacity in both undergraduate and postgraduate training. This change may begin with master's degree programs, followed by doctoral degree programs. Given the high cost of foreign postgraduate training, a sustainable NARS must have capacity to produce most of its replacement scientists.

To this end, NARS must institute policy and structural reforms to expand university roles in research, and universities themselves must adopt policies and develop capabilities to conduct research.

Universities with substantial agricultural research and development may need strategic plans, monitoring systems, and systems for setting priorities. Many must give attention to research management and policies and must address operational issues similar to those in NARI. These issues include:

- providing incentives for research;
- maintaining and upgrading research facilities;
- encouraging contract and grant research, funded by diverse sources;
- obtaining intellectual property rights and commercializing some research products and services; and
- improving the utility of universities' most valuable assets—relatively low-cost postgraduate students.

GCHERA's Call to the Challenges

Though the challenge of feeding a growing population in the 21st century appears vastly complex, three striking advances could make the task feasible: integrated gene management, natural resource management, and information technology. Together, these offer the potential to radically reshape the world's agricultural and food systems. The Global Consortium of Higher Education and Research for Agriculture (GCHERA) is uniquely positioned to use these powerful new scientific breakthroughs. As it always has been in the past, higher education has been a leader in the application of molecular biology and the techniques of natural resource management as well as a pioneer in using information technology to meet the challenge of fighting poverty and feeding the world.

Molecular biology encompasses the new understanding of how genes work, as well as the techniques and tools of biotechnology that make it possible to manipulate genetic material as never before. The information and communications revolution presents a tremendous new opportunity for GCHERA to bring scientific knowledge and indigenous and local knowledge together to bear on global challenges, and to make this information available to its constituents. GCHERA must be at the forefront of harnessing these frontier sciences and technologies to pursue its mission.

Used appropriately, these breakthroughs could lead to improved productivity and the more diversified crops required for future needs. It is possible, however, that these advances will not be equally available to developed and developing nations. One of the main priorities of GCHERA, then, is to work closely with IARCs to ensure that the new science and information technology enhances the food security of the poor rather than impairing it.

These advances in the new science and information technology will complement and enhance existing approaches, not replace them. GCHERA may wish to consider the network concept, extensively applied by IARCs that specialize in crop improvement. For example, IRRI in the Philippines, ICRISAT in India, and AVRDC in Taiwan have established regional and subregional networks for variety testing, collaborative research, personnel training, and information exchange. GCHERA may establish similar regional or subregional networks for collaboration among agricultural colleges and universities in new sciences research, distance education, graduate training, and scientific information exchange.

That approach could also apply to the role the Consortium must play in ensuring that the developing world reaps the benefits of the gene revolution. GCHERA is well positioned to apply these tools swiftly to the problems of the developing world. In doing so, GCHERA may fulfill its mandate to ensure sustainable food security for the generations to come.

Interdisciplinary Research in Agriculture for Better Food and Nutrition

Roger N. Beachy
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The study and practice of agriculture have changed substantially in the past ten years and may be quite different from what many of us studied as graduate students. My training was in classical plant pathology at Michigan State University, and my interests later led me to the emerging field of molecular biology. At The Scripps Research Institute, I recognized more fully the discrepancy between the technical approaches being applied to modern biomedical sciences versus modern agriculture. One of the research goals at the Danforth Center is to bridge that gap through interdisciplinary research.

The Center's Mission and Development

The Donald Danforth Plant Science Center aims to integrate and incorporate cutting edge research of selected aspects of the life sciences into plant science and agriculture. Established in 1998 as an independent, nonprofit 501(c)3 entity, the Center's mission is to:

- Increase knowledge of plant biology.
- Apply any new knowledge to improve health and nutrition and sustainable production in agriculture.
- Facilitate the rapid development and commercialization of promising technologies and products.
- Contribute to the education and training of graduate and postdoctoral students, scientists, and technicians from around the world.

Research at the Danforth Center is supported by grants and contracts, primarily from the federal government, from the Center's relatively modest endowment, and, in the future, fees that are derived from licensing of technology. The Center holds and owns its own intellectual property much as universities do.

The Danforth Foundation and the Monsanto Fund provided the initial funding for the Danforth Center with no "strings" attached to the funds. Additional support came from the state of Missouri. With these resources, we developed a 150,000-square foot, state-of-the-art research facility that opens in October, 2001. When fully staffed, the Center will have 17 to 20 principal investigators and sufficient space for 250 scientists, plus support and administrative staff. The facility was constructed to maximize opportunities for scientific collaboration. Its design provides researchers with opportunities to interact daily, hourly, or minute-by-minute, sharing information and equipment that will drive discovery in the plant and life sciences into a new era.

Modern agricultural research must expand its technical capacity to meet three critical challenges: producing greater supplies of food to nourish a growing population; sustaining the environment throughout the production process; and extending research to embrace food safety and nutrition as well as production.

The Center's broad goals are to:

- Conduct research at the cutting edge of science.
- Contribute to nutrition and health in developing countries.
- Improve the quality of nutrition and health in developed countries.
- Recognize the rights and needs of developing countries in intellectual property policies.
- Gain national and international recognition based upon outstanding science.

The facility will have state-of-the-art instrumentation in cell biology, computational and structural biology, biochemistry, and chemistry, as well as molecular physiology and pathology, and genetics. Of necessity, it will include nearly all of the scientific equipment required for basic research in plant biology, including functional genomics and proteomics.

The Center's Partnerships and Leadership

Because we have limited numbers of staff and other resources and a focused research mission, the Center has developed partnerships with three major land-grant institutions: University of Illinois, Urbana–Champaign; Purdue University; and University of Missouri, Columbia. Other essential partners are Washington University in St. Louis, the Monsanto Company, and the Missouri Botanical Garden, with one of the largest collections of plant and biodiversity.

Through collaborative research efforts, the partner institutions develop programs and initiatives in a much broader range of disciplines than those represented solely at the Danforth Center. We are not an institute of agriculture, yet the science we do will likely interface with research conducted in many departments in colleges of agriculture, including departments of nutrition.

The Center's distinguished Board of Directors includes members from the public and private sectors and the scientific and business communities, as well as chancellors and presidents of the partner institutions. Board Chairman William Danforth is a former chancellor of Washington University. A Scientific Advisory Board reports to the Board on the quality of science and the progress the Center has made toward meeting its scientific goals. The Science Liaison Committee, consisting of scientific leaders from each partner institution, formulates interactions and encourages research partnerships between institutions and individual scientists.

The Unique Research Environment

To accomplish the Center's goals, it is imperative that we establish a world-class research environment built upon synergy between scientists. The research environment at the Danforth Center will be somewhat different from those at research universities. First, the physical setting encourages collaboration among investigators and strives to minimize "empire-building." Second, state-of-the-art equipment is available for all Center researchers and affiliated partners. Third, much of the research at the Danforth Center will be interdisciplinary and collaborating scientists will solve their scientific problems using physical, biochemical, and biological approaches. Fourth, scientists and support staff are not tenured and sign multiyear contracts; contracts are renewable based upon performance standards. Evaluation for contract renewal for principal investigators will include review of interactions and collaborations. Fifth, with no tenure system, the Danforth Center expects its scientists to secure a portion of their salaries from grants and contracts. Lastly, most principal investigators are adjunct faculty members at one or more of the academic partner institutions and perform a limited amount of service at the affiliated institution. Graduate students at partner institutions may choose to conduct their research projects at the Danforth Center and will receive degrees from the academic institution.

The Center's Initiatives

During the next 5 to 10 years, research at the Danforth Center will focus on five primary initiatives, each of which draw heavily on expertise in computational and structural biology, biochemistry, cell biology, and genetics.

The International Laboratory for Tropical Agricultural Biotechnology

Established in 1991, this organization conducts research and provides training for students and other scientists from developing countries. During the past ten years, this laboratory trained more than 130 scientists from 20 countries, 70 percent of whom were repatriated to their home countries.

The International Laboratory for Tropical Agricultural Biotechnology (ILTAB) is currently focusing on cassava, an important food crop in Africa and Latin America. The goal is to increase the nutritional value and productivity of cassava, while lowering its high susceptibility to many diseases.

Three other research initiatives at the Danforth Center have potential applications in future ILTAB research programs.

Improving Plants for Human Health and Nutrition

The initiative to improve plants for human health and nutrition includes research programs that seek to improve levels of bioavailable micro- and macronutrients, (e.g., vitamins, iron, zinc, copper, etc.) and changing the levels of certain phytochemicals to improve the health benefits of foods.

The world population will require greater amounts of food of high quality and nutritional value. The World Health Organization and other sources report that more than two billion people suffer to some

degree from iron anemia. Iodine deficiency causes disorders in 740 million people. Twenty-three percent of births each year show growth retardation due to malnutrition. Many children under the age of five suffer chronic malnutrition. This research initiative seeks to address some of these issues.

The other initiatives at the Danforth Center include:

- Plant nutrition and studies to improve plant response to water stress;
- Studies of novel mechanisms of pest and disease resistance; and
- Studies to enhance production of novel materials and biobased products in plants.

Partnerships

Since our founding, we have been reasonably successful in securing funding from public, private, and government sources. To date, we have received grants and contracts from five different companies from three countries, and from the NSF, NIH, DOE, and NASA. The private sector contracts are relatively modest in scope and support the work of individual researchers. The U.S. Department of Agriculture (USDA) Agriculture Research Service will sponsor two researchers for studies to improve soybean quality. While housed at the Danforth Center, these scientists will retain strong linkages to the University of Missouri, Columbia, and other soybean researchers in the region. Agreements for other research collaborations are being developed with national and international programs around the world.

The Process

Given that there are many more good ideas for research than there are funds to conduct research, especially in the exciting fields of plant and animal genomics and proteomics, it may be essential to prioritize research goals in agriculture to meet the longer-term challenges. The critical question in this process is: Who chooses the targets for research?

In the academic environment, we ask our scientists to decide what they want to work on and expect them to search for grants and contracts to provide resources. In a corporate setting, the director of research or a group leader often makes the decisions. The USDA has several levels of key personnel that establish direction. At the National Science Foundation, it's the leader and a broad consensus that establishes funding initiatives.

Perhaps as administrators, we should take the initiative to examine our institutional research decision-making process. With good input, many of us can identify which areas are most important to our institutional mission. I am suggesting that we set research priorities with a broader range of stakeholders than was done in the past: include farmer/producers, technologists/scientists, private interests, consumers, regulatory agencies, economists, social scientists, and possibly politicians.

After setting research priorities, a team may establish the role of basic and cross-disciplinary research, coupled with a goal-oriented direction to achieve the desired end. This approach characterizes many of the Danforth Center research programs which involve interactions with partner institutions. Our research faculty will bring to the Danforth Center a broad range of technical skills, including computational and structural biology, cell biology, chemistry and biochemistry, molecular physiology and pathology, and genetics.

Research collaborations within the Center and with scientists at partner institutions will add additional scientific skills and bring higher value to the research programs. Such synergy will enable scientists at the Center to address complex research questions. These cooperative relationships will provide the means for scientists to move beyond genomics and gene sequences into the more exciting arena of protein function, and to develop new plant varieties that achieve the long-term goals in food, nutrition, and agriculture.

The Initial Phase of Agri-biotechnology

In the initial phase of agricultural biotechnology, private sector-public sector collaborations successfully developed technology and traits, some of which were commercialized. This led to new products that reduced the use of certain agrochemicals, bringing direct benefits to the farmer/producer and the environment and indirect benefits to the consumer. The collaboration lessened in part because only the private sector could finance the costs required for product approval and commercialization of new products. Because regulatory approval of new products is costly, public sector research institutions are virtually excluded from participating in product development and commercialization, a phenomenon that may dramatically impact the development of new products in the future.

The Second Phase

During the past ten years much was learned about "molecular" plant breeding, quantitative traits, protein design, and gene construction. Yet, we are poorly

prepared to use the massive amount of new information in applications that will benefit humankind in this, the second phase of agricultural biotechnology. During this phase, scientists will conduct research to more directly benefit the consumer, the environment, and the farmer producer. We will continue to adapt marker-assisted breeding and genetic transformation techniques to produce crops with higher yields, greater tolerance to drought and other abiotic stresses, and reduced reliance on certain agrochemicals. However, there will be greater emphasis on developing foods with increased nutritional value, including higher levels of vitamins, microelements, and beneficial phytochemicals. Our research will correlate the relationships between food composition and health and will verify the long-term benefits (if any) of foods and food constituents on certain health conditions, including cancers, diabetes, obesity, senility, and others. This will bring greater opportunities for collaborations between plant biologists, agricultural scientists, human and animal nutritionists, and health researchers than ever before.

During this phase, there are many opportunities for broad interdisciplinary research between many scientific fields and for creating even more research partnerships. And, while public sector-private sector partnerships will conduct some of the research related to food and health, we expect more government-sponsored research in this arena. Consequently, we anticipate that consumers may develop greater confidence in the new food products that are developed as a result of this research.

Many factors make for a successful partnership. Some of us have experienced failed research partnerships and look back to find that they were poorly conceived, did not involve appropriate partners or stakeholders, did not attract sustainable funding, or suffered from lack of infrastructure. Even in the best situations, we often plan poorly and fail to use available resources wisely. Consequently, research grants are not renewed and partnerships are disrupted. In many cases, we need better preparation and better stakeholder involvement as well as better management and cost accountability to increase the likelihood that partnerships will succeed.

Sharing Technologies with Developing Nations

Most if not all of the research in agricultural biotechnology has either a direct or indirect relevance to food production and human nutrition in developing nations. Demographers predict population increases of 20 to 25 percent in many countries in Africa and Asia during the next thirty years. GCHERA's future mission is perhaps most apparent in these areas.

A recent report from the United Nations Development Program (UNDP) concluded that improving the economic situations in depressed and transitional economies and relieving poverty around the world will depend heavily on investments in new, as well as older, technologies. In this report, agricultural biotechnology was specifically highlighted as being important for the advancement of developing countries. Such investment requires building the intellectual capacities of entities in all countries. The UNDP also warned of the negative impacts that antitechnology protestors can have on the scientific advancement of underdeveloped nations.

Building Partnerships

These and similar challenges to sharing of scientific development should embolden GCHERA members in their goals to develop and enrich cooperative education and research programs between institutions in the north and south. The forms of cooperation in the future must take new shapes, different from those of the past. Programs must involve research of direct value to developing countries rather than promoting models that worked in Europe and the United States. Here are opportunities to develop long-lasting partnerships that bring added value to all partners, including transmitting scientific data electronically and applying modern technologies to local crops.

There are increasing numbers of small technology companies in India, China, Bangladesh, and other countries that work in collaboration with external universities and private sector companies in research and development. These partnerships are especially crucial as the biological sciences move forward in the post-DNA sequencing eras, and eventually find applications to food and agriculture. Scientists in academic institutions can play key roles in making cooperative research programs succeed.

Intellectual Property Barriers

While great potential exists for strong cooperative partnerships among institutions, obvious and perhaps critical barriers can block productivity within such partnerships. Among these, the barriers of intellectual property (IP) may be the greatest. Many universities and institutes take strong IP positions that protect their investment in research and infrastructure, including investment in intellectual capital. Most academic

institutions develop contractual and licensing agreements that relinquish control of key enabling technologies to a single licensee. Such licensing can have a dampening, if not devastating, effect on the use of new technology in cooperative research and development agreements. In particular, scientists and institutional officials in developing countries are reluctant to apply technologies, including those in the agriculture and food sectors, that might restrict the production and/or local commercialization of products. Sometimes the very discussion of IP issues dissuades from negotiations those who are not familiar with the nuances of licensing, patenting, and marketing. Often the reality of the situation is much less onerous than the perception, yet the lack of expertise in the IP arena completely blocks the use of certain technologies out of "fear of the unknown."

I suggest that the academic sector has unwittingly participated in this problem because of policies built on undue expectations. Academic institutions have invested heavily in new facilities and expensive faculty and, in return, expect faculty to conduct cutting-edge science that attracts grants and contracts and to make discoveries that may lead to IP that can bring licensing fees. Few licenses in agricultural biotechnology are likely to be sufficiently lucrative to justify the high expectations of most academic institutions. Yet potential licensees value patented technologies much more than non-patented technologies. It is not uncommon for a licensing agreement to be exclusive; some institutions go so far as to assign most patents to a single entity. Returning licensing fees to the inventor can act as a deterrent to keep the investigator from leaving the institution. Or, the practice can encourage the inventor to begin a new company that through license agreements can benefit the institution as well as the company.

Intellectual Property Reforms

If the inventor wishes to use previously assigned technologies for cooperative research and development in developing countries, it can be difficult or impossible to recover the rights from a sole licensee for this purpose. This can restrict applications of relevant new technologies in developing countries, regardless of the validity of the patent in the country of interest.

At the Danforth Center, we take the position that we will retain the right to use all technologies developed and patented at the Center for "humanitarian purposes." The scope of definition of humanitarian purposes is not fully described, but licensees are asked to agree to negotiate the use of licensed technologies in good faith. It remains to be seen whether such a position will (1) be accepted by licensing companies, and (2) increase the flow and applications of new technologies to developing countries. We hope that other academic institutions will reevaluate their IP policies and consider how they can best encourage the use of their intellectual property most effectively for the benefit of developing countries. Academic institutions may wish to consider the following as potential IP reforms.

- Withhold from license the uses of intellectual property in developing economies for what is broadly claimed as humanitarian purposes.
- Develop licensing strategies for enabling technologies to ensure broad application in the public and private sectors.
- Find ways to invent by circumventing the restrictive technologies that may be limited by many international corporations.
- Develop strategies for cooperative research that facilitate capacity building.
- Discover research in product development that benefits all parties.
- Develop mechanisms that bundle technologies and can serve the entrepreneurial activities for developing nation partners.
- Establish processes to address queries from developing nation partners: resist driving the agenda, but be in a position to respond positively to the partners' agendas.

Final Comments

Time will determine if the research and research policies at the Donald Danforth Plant Science Center are or are not successful. At this point, I feel that there is room for more such institutions. They can free the scientist to conduct innovative, highly cooperative research in a setting that is different from that in the industrial sector and the academic setting. Such an organization can require collaborations and partnerships to encourage innovation and improve productivity of research scientists.

Integrating Food Systems in the New Global Economy

Elaine R. Wedral

President, Nestlé Research and Development Centers, Inc.

Connecticut, USA

My invitation to speak at the 2001 GCHERA conference is evidence that the consortium truly looks at our world as one society. I share a common vision with you, one of building a global community, a community of openness between national, economic, and cultural entities. The objective we share is delivering a sustainable, nutritious, and bountiful food supply; a food supply that our populations need and want. I work for Nestlé, the largest food and beverage company in the world. With $60 billion in sales worldwide, it is nearly as diverse as this consortium's membership.

Two years ago my position with Nestlé changed dramatically. For years I supervised the company's food and beverage product development for customers in the United States. Today I head one of the company's eight strategic technology centers for our global operations. My entire mission and focus are Nestlé customers in the out-of-home environment—ensuring that they receive high-quality food products safely and cost-effectively.

Effectively, our food systems approach provides the right products to the right customer at the right price with added value services to help our operators.

Demographic Demands on Distribution

With this new challenge to integrate our food systems comes the clear need to understand the world and the forces that influence its food systems. How can a university best reconfigure itself to accomplish that?

A cursory glance at changing demographics reveals significant regional and social imbalances that influence modern food systems. Although predictions for population growth over the last twenty-five years fell short, the world's population grew by two billion to 6.1 billion people, an impressive increase. By 2025, 7.5 billion people may well inhabit the planet.

Even more interesting, however, is the change in the age composition. While the world population group of 65 years and older grew by 190 million over the past twenty-five years, this age segment is expected to more than double between the years 2000 and 2025, particularly in industrialized countries, and will represent about one third of the world's population.

The growing demand for basic food in emerging countries contrasts greatly with the more discriminating demand of the industrialized world for a diet that is, if anything, too rich. As a result, we in the food industry face new social and commercial challenges to integrate the desire for foods that enhance wellness in an aging population—offering very specialized, high value-added products—with the more basic food supply needs of rapidly developing nations. And, by the way, all the while responding in cost-effective ways.

We in the food industry also must confront new stresses on our global food distribution systems created by demographic imbalances from urban population growth. As an example, 30 percent of Asians currently live in cities, yet within fifteen years, that percentage could easily grow to 40 or 50 percent. Such growth will drastically alter the food preservation and distribution systems serving these populations; a city of 10 million people can easily consume 6,000 tons of food daily. Such growth demands infrastructure building and investment and an incredible amount of education and knowledge to make wise decisions.

Product flow, transformation, and distribution will require major investments if we must satisfy the changing demands of an increasingly urbanized population and make the whole food chain supply more efficient. The technologies at hand can answer all of these issues. How can we integrate all that knowledge and make it available and useful?

Local food processing industries do not exist in some parts of the developing world, which means that

locally grown food cannot be preserved and packaged locally for sale. In those regions, due to spoilage, only about 25 percent of the local crops actually reach consumers.

If the ultimate goal is to deliver an adequate and safe food supply to all of our populations, universities, government, and industry must respond by emphasizing food preservation, storage, and safety. Consumers demand fresh foods, yet, to deliver them fresh, safe, and with a reasonable shelf life, the food industry requires new technologies, including genetic engineering and telecommunications, and new ways of handling. The food industry looks to organizations such as GCHERA to help it address and investigate these critical issues.

Globalization's Provocations

Liberalization of trade and the competitive nature of a worldwide, interconnected marketplace have compelled large companies like Nestlé Company to restructure their production and delivery systems for greater efficiency and cost efficiency. Globalization forces our hand in being more efficient, and that makes globalization exciting. But, without a doubt, globalization also shows us weaknesses within these interconnected and interdependent relationships.

For example, in early July 2001, we witnessed the vulnerabilities of our interconnected world when signs of an economic slowdown rattled world financial markets. This came after two or three key technologically interconnected industries in one nation experienced a downturn from investments in 100 million miles of cable and networks and about $125 billion to secure communication networks for telecommunications in the future. Because of our interrelatedness, stock markets in eastern Europe, Turkey, Brazil, Korea, Japan, Malaysia, and just about everywhere in the world felt this downturn.

We have also seen globalization bring benefits where trade, investment, and the movement of people and technologies have literally bound nations together. Countries and industries that have promoted such behavior have achieved amazing progress and increased their GNP tremendously. Countries that have participated in this international trade have moved up the economic scale more rapidly than those that have not chosen to trade globally.

Personal income in these countries has also increased, driven in part by increases in productivity and education, longer working hours, and the growing numbers of two-income families. This heightened affluence has driven a very rapid evolution in consumer behavior and preferences toward a dramatic shift from purchasing food that is prepared at home to purchasing food that is prepared and served outside the home.

This shift has, consequently, turned purchasing power away from obtaining basic ingredients for meal preparation toward partially or completely assembled meals requiring little or no preparation and, with some products, no kitchen.

Perhaps I may illustrate this best with the simple example of a birthday cake. Sixty years ago, a mother in the United States would have made her child a cake "from scratch," using flour, sugar, and eggs. The first evolution for greater convenience was the introduction of cake mixes. After that came prepared cakes, offered directly in grocery stores. Today some economists say we do not have just a knowledge economy but an experience economy. They cite parents who go out and purchase a party package for their child's birthday, and the cake is included. A total experience. This increase in affluence and consumerism is not expected to be limited to industrialized countries, since globally we see higher per-capita GNP figures directly linked to increased purchases of value-added products.

With such consumer demands and no real increase in food prices, companies experience tremendous pressure to secure cost efficiency. In response, Nestlé, like many large companies, is undertaking new technology. We will spend a couple billion dollars on a project called GLOBE, a program about establishing common economic factors and business processes throughout the world. We are joining with other food companies to share and unify our existing databases through business-to-business initiatives to leverage knowledge and speed the order, delivery, quality control, invoicing, and economies of scale.

Planning and Public Relations Missteps

One of the value-added benefits consumers also want, if we look at the whole range of products, is improved health. Again, just as we used telecommunications to improve and reduce costs and speed up our supply chain, we can use today's technology to produce large-scale public health improvements effectively. In the past, salt and its fortification caused the virtual disappearance of iodine deficiency, and fluoride treatment in water ameliorated dental health.

Biotechnology could be an avenue to overcoming Vitamin A deficiency, which is so widespread in Asia. Yet, are we ready to implement golden or yellow rice? Are we really prepared to do this?

Some experts have described the development, production, and growth of genetically modified foods as a critical technology for ensuring a nutritious, safe, and sustainable food supply. Others describe this use of biotechnology as unnatural and a dangerous science gone awry. It is reasonable to assume that we all have responsibility for this critical impasse—industry, government, and academic groups.

From the start, industry failed to realize how volatile the perceptions of the new biotechnology were, and opted to go with a strict business plan rather than a strategic plan. The genetically modified crops first targeted to the market were engineered to express traits that directly benefited agribusiness (pesticide-resistance); only indirectly, through lower environmental impact (pesticide production), benefited the consumer; and appeared to hamper farmers in developing countries (terminator technology).

All three of the first genetically modified applications proved easy targets for an antitechnology faction, and industry made no attempt to adequately inform or educate consumers on the scientific basis or potential benefits of genetic engineering.

In retrospect, it might have been more productive to develop a more strategic, long-range approach, first calling on agribusiness, in partnership with research universities, to conduct an effective and formal "risk assessment" of the new technology; then, widely communicating the results for releasing the right information and the right technology at the right time.

After these steps, agribusiness could have introduced a crop that provided a clear nutritional benefit unattainable through traditional plant breeding, such as beta-carotene-enriched "yellow" rice. Had agribusiness taken such an integrated approach, the global consumer might have supported the technology instead of fearing it.

These integrated global delivery systems will have the potential to give the modern consumer unprecedented access to a highly varied and nutritious food supply. If the benefits of biotechnology are to be fully realized in the future, scientists and universities must reengage in dialogue and build a base of understanding and trust with the consumer. Just as a lack of effective information management can be detrimental, the selection of the right management tools allows us to navigate our sophisticated information landscape, extracting what we need to increase overall productivity and to meet our global consumers' changing expectations. This ability is vital but difficult to develop. We confront a flood of information, not a lack of information.

Today's world presents many challenges, changes, and questions. How should universities respond to these changes? Changes, such as smart machines equipped with artificial intelligence and expert systems with greater memory banks that are becoming the quasi-PhDs of the food industry!

Regardless, humans have an edge—an edge in reasoning and judgment, in addition to critical skills analysis. They make connections that machines cannot. Because of this, we must emphasize educational training with more rigorous and challenging multidisciplinary and interdisciplinary studies.

An article I read recently on recruiting explained to business and industry that, to select the best employees to provide the best opportunity for the company's future innovation and success, we cannot continue to hire based on the candidates' knowledge of the technical discipline. We must hire the candidates' minds; i.e., their critical thinking abilities.

The article went on to discuss communication in the workplace. It stated, "The various constituencies within the business enterprise must learn to communicate with each other more effectively." These constituencies, especially in international relationships, communicate in different languages. Despite that reality, finance executives should comprehend Moore's Law, or marketing specialists should grasp the importance of software in modern gear. The article's author concluded that business is as much an educational process as it is a communication process.

Even within the technical community, different professions carry with them prejudice of sorts. The engineer who derided the Ford physicist's early use of lasers laughingly accused him of planning to replace the spark plug. He would later acknowledge that those lasers were key tools in fostering understanding of the combustion process and in improving engine efficiency.

Many corporate executives behave as though they are in a horse race. Have you felt that pressure? I certainly have. We must train ourselves to look at an

opportunity or challenge as a whole and not focus our attention very narrowly on a target only a short distance away.

The Call to Universities

Real innovativeness in an industry requires broadmindedness—another critical skill to develop. There must be a willingness to see alternate ways of doing things, of not necessarily doing them the way we do them today. Inertia is the greatest enemy of innovation. We must seek and encourage alternate marketplaces and alternate approaches to any given marketplace. Corning's success was due precisely to identifying new potential markets that could take full advantage of the company's technological prowess. Do our agricultural curriculums stimulate such innovative thinking and problem solving?

Agriculture is no longer only concerned with producing adequate food but also ensuring that, from the field to the plate, the food reaches our people safely. Do our university curriculums adequately address this integrated food chain?

Learning must become a much different and lifelong process. Learning skills are critical because we live in an environment where information grows 200,000 faster than our population. I read that, to be viable in our information society, the typical adult must take at least thirty semester hours or credits every ten years. Are our universities organized to manage this growth in adult and postsecondary education? Do you feel that you should?

Today we cannot simply produce technology. Our consumers have made that clear. We also must properly communicate technology's value to the global marketplace—its benefits and its risks. This is another very difficult but critical task.

Are we prepared? How do we prepare our students for this task?

To be successful in the long term, we must rapidly learn from our mistakes, and we have made some. We must be flexible enough to adjust our thinking and gain a genuine understanding of the major forces that influence, shape, and modify our global society.

For a start, universities may choose to work toward integration and understanding within their many different departments and disciplines. Such work is vital today because, realistically, in our global economy, integration and interdependence have become necessities.

In forming this consortium, GCHERA has taken the first step to collaborate, share, and integrate technologies. GCHERA has truly a special opportunity for the potential you have, together, throughout the world, is limitless.

A University Action Plan for Servicing the World's Changing Food Systems

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In high-income nations, the percentage of the population employed on farms has dropped to low single digits. Yet, in many of these same nations, workers in the food sector make up 20 to 25 percent of the total workforce. This is understandable only if we recognize that the food sector begins in research laboratories that spawn the next generations of technology, which progresses their discoveries to input supply industries, on to farm production, moving through the marketing and processing sector, then to the wholesale and retail distribution sectors, which take food products to the consumers' final points of purchase. I submit that traditional colleges of agriculture must accept as their mission the servicing of future players in the entire food system, spanning through each link of this food sector chain.

Changing Nature of the Global Food System

Because rapid and unpredictable change characterizes the 21st century, our graduates must be prepared to deal with a changing environment to be successful. Let's take a closer look at the changing trends so we can analyze the implications for agricultural colleges and universities and the actions we must take.

Global Demand for Food

Too often in the past, farmers have viewed their job as growing whatever they were good at growing or whatever they liked to grow, and it was somebody else's responsibility to pay them for growing it and to move it along to the public. Today those of us in agriculture must acknowledge that consumers drive the entire food system, not farmers.

Consumers propel the rapidly growing and changing demand for food all over the world. At the World Bank, we project a doubling of world food demand by 2050. We expect population to grow about 48 percent from the year 2000 to 2050 from 6 billion to 8.9 billion. That estimate is accepting the United Nations' medium projector.

Rather, population growth creates need, or more mouths to feed, but it does not create effective demand. Purchasing power creates food demand, and today 800 million people go to bed hungry, mainly because they lack the purchasing power to access an adequate diet.

Our numbers suggest that there are 1.2 billion people in the world who live on less than one dollar per day. Almost half the world's population lives on less than two dollars per day. But any reasonable success in broad-based economic growth that empowers several hundreds of millions of these low-income people with the income and purchasing power to upgrade the quality of their diets will contribute at least as much to global food demand as to population growth. From this projection, the World Bank concluded that the world's farmers by 2050 must be prepared to grow twice as much food as they do today.

Urbanization, which continues at a very rapid rate, further accentuates changes in diet. From very low to middle levels of income, people tend to move up the carbohydrate chain from roots and tubers to rice to wheat. They also increase their consumption of animal protein, fruits, vegetables, and edible oils. In the middle- to high-income ranges, they demand more convenience and specialized quality characteristics in the food products they buy. They have the purchasing power to buy their food produced in any manner they wish, whether it's organic, free-range, or non-genetically modified because someone is always willing to supply them. As the opportunity costs of women's time rises, they also economize on this scarce asset by buying more convenience products.

Because we expect the demand to continue to increase—demand for services, packaging, specialized farm products, and value-added after the farm gate—the percent of the retail food expenditure that farmers

receive will probably continue to decline as per-capita incomes rise. Today U.S. farmers receive less than 25 percent of the retail price, and similar trends are likely to surface in most other countries of the world. With consumers as the food sector's royalty, we must acknowledge that they drive the changes in global food demand. And these changes ripple all the way back to the farm and the input industries.

Public to Private Sector Marketing Systems

The marketing system that links farm production with consumers is increasingly focused on what today's consumers want to buy and on ensuring that the farm gate hears those demands. Ever-larger marketing firms, created by mergers and acquisitions, accomplish this by increasing vertical integration and contracting between processors and farmers. Often multinational firms source their inputs in one country, process them in another, and sell them in a third. Some of these multinational corporations have annual turnover significantly larger than the GDPs of many of the developing countries in which they operate.

As public sector agricultural marketing firms were privatized, the role of the private sector in agricultural marketing increased. Privately owned firms were quick to significantly reduce employment levels.

Marketing systems in developing countries, particularly as parastatals have been privatized, have not served small farmers particularly well. One of the greatest tragedies in this very progressive transformation of state-owned enterprises into private firms is that today's marketing institutions often serve small holders less well than they were served in the past. Markets often work poorly due to high transport costs, lack of telecommunications, and lack of reliable electric power. It is next to impossible to add much value to the land's raw products.

At The World Bank we look to the potential role of agricultural marketing cooperatives in filling this gap. Yet, developing countries are strewn with failed cooperatives. We know that co-ops played an important role in the agricultural development of northern Europe, North America, and Japan; yet, we must ask, why has the same form of business been less successful in serving the agricultural development needs of many developing countries among their small holders?

The marketing systems in developing countries are becoming increasingly linked with those in high-income countries through globalization.

The agricultural marketing system increasingly must ensure the identity of the products that they're promoting, particularly those products that are shipped into high-income markets, increasingly so in western Europe.

Freer International Agricultural Trade

The world's food and agricultural business is very much a global activity today.

Freer international agricultural trade, which is a result of the Uruguay Round Agreement in agriculture, drives globalization. The percent of the world's agricultural production that's moving through international markets has risen in the last couple of decades, and we expect this to continue. Our research shows that those parts of the world where we expect food demand to grow rapidly are often countries that have very little land per capita.

We also see a trend to expand international trade to value-added and higher-value agricultural products, due, in part, because food processors and supermarkets promote global sourcing of products.

"Know-how" is extremely important to the level of competitiveness that exporting countries achieve in the international market. Knowing how to efficiently produce products is key, but they must also exhibit "know-how" in international marketing and "know-how" in meeting product quality standards, including sanitary and phytosanitary import requirements in the markets of high-income countries. Again, we see a growing role for multinational firms in carrying out this business.

Productivity of Food Production

The World Bank's analysis of world food production suggests that to double food production on this planet in the next fifty years, we must initiate a major increase in productivity of the land, water, and labor used in food production.

Land Productivity. Increasing land productivity seems an unlikely avenue for success. Only about ten percent more land is available that is not highly erodible, subject to desertification, or presently forested. We can double the number of hectares under cultivation, but only through unacceptable environmental outcomes—massive forest destruction, which causes critical losses of wildlife habitat and biodiversity.

Water Productivity. Water is likely to become an even more binding constraint. Agriculture uses 70 percent of the water used in the world today. It is the largest water user and the largest water waster. To most of the world's farmers, water has no cost, and people tend to waste any product they perceive as free. With the rapid rate of urbanization, cities will successfully outcompete agriculture for available water, so the world's farmers will strive to double world food production with less available water than they have today.

Labor Productivity. The solution that remains for doubling food supplies by 2050 is doubling the average labor productivity on the fertile, nonerodible soils now in production. As an extreme case in point, a particular problem of increasing labor productivity exists in sub-Saharan Africa today because of AIDS. I visited a number of villages there where I saw children and old people but no one of middle age. The male and female populations of productive working age are gone because of the AIDS epidemic. In sub-Saharan Africa, labor saving technologies gain importance as a factor in solving the problem of food security.

Rural Poverty. Labor productivity must also rise so agriculture can contribute to solving the problem of rural poverty. In every country that has experienced economic growth, the percent of the population employed on farms has dropped. Frequently, at low levels of economic development, the agriculture sector is characterized as one of significant poverty, with significantly lower incomes than people enjoy in the rest of the economy, in part, because of agriculture's lower labor productivity when compared to productivity in other economic sectors. One important aspect of poverty reduction in agriculture has been increasing the average size of farms, driven principally by farm families' desire to escape poverty.

Moreover, along with the growth of farm size there has been a tendency toward bifurcation. With a rapidly shrinking number of farms—farms large enough to provide the farmers/operators with commercial viability and market rates of return for the families' invested labor and management—comes an increasing number of farmers/operators of small-sized farms who shift to farming part-time. In reality today, a low-income family farm can increase its net family income by only a very limited number of approaches. It can:

- increase the amount of land cultivated per person;
- grow higher value-per-hectare products on the family's existing land;
- increase the productivity with which the family produces the products it grows; or
- farm part-time.

Nonfarm Employment. Rural-to-urban migration has always been an essential part of the process of eliminating world poverty. But with the rapid rates of such migration in today's developing countries, more and more cities broach an unsustainable size. Creating nonfarm employment in rural areas is therefore essential.

Many Americans are surprised to learn that 75 percent of the people we count as U.S. farmers today earn most of their family income from nonagricultural sources. Indeed, nonfarm employment is a completely normal part of economic development in agriculture, as evidenced in North America, Europe, and Japan. There, they addressed rural poverty by putting into place infrastructure and employment opportunities within commuting distance from farms so that most small holders migrated out of agriculture at 8:00 a.m. and returned at 5:00 p.m., i.e., converting most small farms into part-time farms.

Adoption of New Technologies

While the world has plenty of food available today and at very low cost—real commodity prices are the lowest within the last century—we need a significantly greater amount of research to ensure a continuing flow of new technologies. The world's farmers in both high-income and low-income countries need new technologies to increase the productivity of land, water, and labor.

Public policy plays a key role in agricultural production today and in the future. We know that better technology is available today in many developing countries, but many farmers do not adopt it. It's ironic that in the high-income countries, which have such a small percentage of the population engaged in farming, agriculture is extremely successful in extracting economic rents or income transfers from their legislators. While in developing countries, the numerically larger group of farmers has virtually no political clout, and their governments tax rather than subsidize the agriculture sector. Their governments also make rural areas less attractive places to live and work because they underinvest public funds in rural schools and rural health care, which keeps the rural areas lagging behind the same nation's urban areas.

Farmers in developing countries on average pay more than the world market price for their fertilizer, yet receive less than the world market price for their

outputs. For their situations, they simply do not view adopting new and improved technologies as profitable. When one adds the pronounced urban bias in public investments, infrastructure, and human capital formation, it's no surprise that those farmers are laggards in adopting technology.

The high transport costs associated with the miserable state of rural roads in many developing countries make the cost of inputs prohibitive and lowers product value. Markets today do not work well in the absence of telecommunications. We witness a widening information gap between high- and low-income countries associated with differential access to the Internet and the World Wide Web. How can rural farmers access the Web or the Internet if no telephone or electric service exists? Without a solution to sluggish infrastructure investments in rural areas, we'll continue to watch the gap in productivity and competitiveness of agriculture widen between the haves and the have-nots.

Implications and Actions for Agricultural Universities

Agricultural universities all over the world have found it difficult in recent years to sustain their optimal number of students and attract the best students. Might this be the result of excessive focus on what happens on the farm rather than servicing the needs of the entire food system or the entire food and agribusiness sector, which includes the farm? We must assess our curricula to ensure that we are serving the entire food system.

Address Fragmentation

Frankly, too many colleges of agriculture and universities operate in this world. Consequently, we fail to capture the economies of scale, i.e., the excessive number of graduates relative to the demand, especially in lesser-populated countries or small states and provinces in heavily populated countries.

Although it often results in suboptimal capacity and duplication of effort in our programs, politically it's often required to have a college of agriculture. Distance learning can help compensate, but the problem of considerable fragmentation remains.

We must be absolutely certain that our science is impeccable. It must be objective so criticisms of bias in our research are not forthcoming.

Prepare Skilled Students

Key people at agricultural universities must also develop closer relationships with their customers who hire their graduates, so the universities may investigate whether they give the world the educated workforce it wants and needs. Universities must avoid excessive rigidity in the agricultural curricula because studies show that the majority of graduates in agriculture, ten years after graduation, are working outside their major subject area.

We must ensure that agricultural universities are preparing students for lifelong learning. Obviously, they must be trained for credibility to the first employer who hires them. But because of the extremely rapid changes in technology, science, and the global marketplace, our students must apply and enhance their skills as they continue to learn.

They need excellent communication skills. The World Bank actively engages with civil society and nongovernmental organizations whose representatives often criticize what is taught in the colleges of agriculture and national agriculture research systems. Our graduates must effectively communicate in writing and speaking if they are to debate those who denigrate what they learned and what our universities teach in agricultural science.

Integrate Teaching, Research, and Extension Functions

I am very concerned about the situation in agricultural teaching, research, and extension in countries where different ministries perform these three functions. The U.S. land-grant university model has demonstrated the high degree of complementarity that exists among these three functions. In many developing countries and in many other countries of the world, the research and extension functions, for example, are divorced from the teaching function.

The World Bank often finds a lack of credibility in these three functions because, for example, the extension function does not have an adequate research foundation to its mission and the research function employs inadequate feedback mechanisms that prevent them from adequately communicating with farmers. Research results then have no easy way back to the farms. Without extension, the teachers are not at the cutting edge of what's going on in the fields. We must seek ways to increase this complementarity.

Frequently, the graduates of agricultural universities, particularly in developing countries, lack credibility

with the farmers they serve. They simply cannot empathize with the real-world problems of the farmers because they have no practical agricultural experience and do not really understand the challenges of rural life. One of the strengths of the U.S. land-grant university is the manner in which it pulls children raised on farms in rural areas into the universities and turns them into professionals who work in the agricultural sciences throughout the industry.

Colleges of agriculture make students better farmers, but few graduates today become farmers. The entire food system needs people who know what they're talking about in both the technical sense and the practical sense. Unfortunately, in many developing countries, the primary and secondary school systems are inadequate to prepare many farm-raised children with the necessary skills and knowledge so they pass the entrance examinations required for agricultural universities.

Lobby for Priority Funding

We must serve as watchdogs so that our agricultural universities do not act in ways that encourages the public to perceive us as part of what is called the "ivory tower," or excessively isolated from the real world. This drop in credibility has, indeed, occurred in a number of countries, resulting in declining financial support. An agricultural university, as well as an agricultural research system, will command public support and public appropriations if, and only if, the public perceives it as solving the known problems of the nation's food and agricultural systems.

Avoiding "ivory tower" isolation applies as well to public agricultural research institutions. Public appropriations have declined severely in some of the countries of eastern and central Europe, as well as in many developing countries when their agricultural research institutions appear too oriented toward peer research. The public wants such institutions to solve farmers' real world problems and engage in dialogue with farmers, who communicate with researchers, who report their findings to agricultural colleges.

While public investment in agricultural research has declined significantly, we record an increase in private sector investments in the world's high-income countries. In part, this trend is due to provisions of intellectual property protection through patenting of biological materials. Companies that developed such technologies during the past few decades have enjoyed more protection than companies' mechanical inventions of the century before.

The private sector will only make investments in agricultural research if it can gain a return and recover the investment costs, as it provides a return to its shareholders. Some activists in nongovernmental organizations have criticized the private sector for this rationale, but they simply cannot have it both ways. If the U.S. Congress and the parliaments of many European countries have reduced public investments in agricultural research and turned it over to the private sector, while they enacted patent laws that protect intellectual property, what other outcome should we expect?

Rather, may the activists invest as much of their communications budget in lobbying to support higher appropriations for agricultural research. I too believe in the "public good" nature of agricultural research. I believe that consumers and farmers benefit significantly from public investments in research that generate freely available technologies. If we're not going to invest public resources in that research, it is inevitable that the inputs we buy in the body of those improved technologies must be priced higher to recover research costs.

In developing countries, the challenge is even greater. Investments in agricultural research there have also been declining, but the private sector has not stepped in to fill the gap. Simply no available market rate of return on investment, which would be payable in foreign exchange, exists to create an attractive prospect for private sector firms. To have a continuing investment in the public support for agricultural research is even more important to developing countries than it is to high-income countries.

Investments have also declined because foreign assistance, foreign aid, or official development assistance in agricultural research has been cut. The World Bank has declined significantly in granting loans in support of rural development in agriculture. Last year's lending figures were the lowest in the history of The Bank. Surprisingly, these lower figures are not from The Bank's desires to cut back loans, or because we've decentralized and become more demand driven. The developing countries frankly have not demanded as much for agricultural research or agriculture development as they have in years past.

The Bank believes that there are several reasons for the decline in borrowing in support of agriculture development, including agricultural research. These reasons are, first, low commodity prices and, second, the lack of political clout of farmers in developing countries. And, third, agricultural development is a

long-term investment, and our political bosses in many developing countries are demanding shorter and shorter payoffs or quick fixes, partly because of their urban bias. Partly, we fight the perception that agriculture is old, boring, and passé. Legislators prefer investments in exciting high-profile areas, such as disease control or population control. And finally, the ministries of finance with whom The World Bank interfaces are simply not telling us that agriculture is a priority.

Somehow we must regain agriculture's position on the global agenda. The World Bank has more resources available to lend for agricultural and rural development than in demand. If developing countries request funds, the monies can help strengthen instruction in colleges of agriculture, strengthen agricultural research, or strengthen extension services. But, to rebuild demand from The World Bank and from official development assistance donors, significant change in the political realities of nations—low-income and high-income—must occur.

Lester Brown, Thomas Malthus, and the Club of Rome have all been wrong over the last 100 or 200 years in their forecasts of doom. The reason they've all been wrong is they assumed static technology. I believe deeply in the public good of agricultural research, education, and technology transfer, but we must develop greater political support for these activities or we're not likely to achieve it.

Supply has significantly outstripped demand in agriculture. Supply is one reason why we have the lowest real commodity prices of the last century. We must make investments in agricultural research to produce tomorrow's technologies, which colleges of agriculture will transfer to their students and ultimately to the professionals who conduct research, and the professionals and the universities will diffuse new technologies to the farmers through extension.

Revising India's Agricultural Curriculum

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In the 21st century, agricultural production has become a process of applying science in developing and managing technology and informing and training farmers in these processes. Relatively low levels of literacy among most farmers in developing nations present complex challenges to their higher education institutions that offer an agricultural curriculum. With world population estimated to reach ten to eleven billion by 2050 and such growth expected primarily in the developing world, farmers there must know and apply more efficient methods to increase food production.

The instructional methods that higher agricultural education use generally involve soon-to-be farmers in the decision making processes of developing technology, choosing technologies and treatments, implementing projects, and sustaining project gains. If farm graduates do not use, apply, or manage these "state of art" technologies properly, problems, sometimes even irreversible ones, may arise, which may lead to stagnation in production or even declines.

Experience shows that technological solutions are external to the local environment, often creating adaptation problems. The agricultural curriculum, in the developing world's higher education institutions, requires a strong feed-back mechanism within the transfer of technology chain to quickly recognize and resolve such problems. Another dimension it must contain is the globalization process, which presents stiff competition of world trade. Globalization imparts larger obstacles for nations with limited capacity and means to help their farmers respond to market forces.

Moreover, the curriculum must train students in managing trade and agricultural commodities inventory, a specialized operation that requires assessing different regions' demand-supply positions, as well as creating and managing infrastructure for storage and transportation facilities. It must teach its farmers methods and strategies to increase production efficiently while protecting the environment.

Higher education institutions in developing countries must add continuing education to their formal, rigid agricultural curriculum. Continuing education must address the needs of illiterate, unskilled farmers and farm households. Such a curriculum would give individual farmers access to agricultural facilities at different stages of their lives. It would also relate the educational process more directly to local conditions, making learning more meaningful. Serving officials in the Private and Public Agricultural Extension Systems and Corporate sector will also benefit agricultural production.

India's Agricultural Curriculum

Agricultural education has played a very important role in India's socioeconomic development. Agriculture in India supports more than 60 percent of its population and 80 percent of its poor. The agriculture industry contributes close to 30 percent of the nations' gross domestic product and generates about 20 percent of India's export earnings.

The History of Agricultural Education in India

Historical evidence reveals that agricultural education existed in the monastic Nalanda University and Takshila University during India's medieval period. However, only after six agricultural colleges were established at Kanpur, Lyalpur, Coimbatore and Nagpur in 1906, Pune in 1907, and Sabour (Bihar) in 1908 were students offered organized courses in agricultural education (Paroda, 1999).

At the time of independence in 1947, India had 17 colleges that offered courses in agriculture and allied sciences. Soon after independence, the Government of India appointed a University Education Commission (Dr. R. Radhakrishnan, Chair) to review higher agricultural education to suggest ways to increase

food-grain production. The commission recommended that India make agricultural education a major national priority (Paroda, 2000).

In 1955 the United States offered its assistance. The first Indo-American team studied India's agricultural research and education and recommended strengthening higher agricultural education and adding veterinary education to the curriculum. It further recommended that the U.S. governments' substantial grants-in-aid subsidize the development of rural universities in India. The first university of its kind opened in Pantnagar, Uttar Pradesh state of India in 1960. By the late 1950s, the Indian Council of Agricultural Research (ICAR) had undertaken an assessment of the university courses and formulated a model curriculum.

In 1964 an agricultural education committee (Dr. Ralph W. Cummings, Chair) (Jain, 1999) recommended establishing universities in six states of India, based on the U.S. land-grant college system. Each had a strong curriculum in agriculture, animal science and allied sciences. Today India has 32 agricultural universities in its higher education system.

The Status of India's Agricultural Education System

India's state agricultural universities (SAUs) and other important institutes of agricultural education have embarked on an ambitious program of developing a suitable agricultural education system both at the undergraduate and postgraduate levels. They have reviewed the agricultural education system and the lessons learned over the years have been at the heart of these reforms.

The program began with setting goals to prepare graduates so they would become job providers rather than job seekers. Another priority was training the faculty members in agricultural education to update their mind-set about instruction and train them in modern teaching, research, and extension approaches.

Although, India owns one of the world's largest systems of agricultural education, until recently, the SAUs' agricultural programs were not effectively accredited, resulting in lack of uniformity, low standards, poor quality of education, an absence of modern teaching techniques, a wide variation in examination and evaluation systems, lack of staff mobility, and poor student mobility among universities and states.

Many SAUs also lack modern management systems, they have poor library resources and poor teaching facilities. The system urgently needed a well-defined regulatory mechanism, human resource development and human resource management programs, a reorganization of support systems and strategies to rejuvenate the entire agricultural education network.

Traditional Curricular Orientation

India's agricultural education system is entrenched in traditional ways of crop production with very little attention paid to value addition, e.g., storage, cold storage, transportation, and processing. Similarly, the system lacks emphasis on market research, demand projections, exploring markets, export potential, and production technologies.

The current system works within the paradigm of transfer of technology from the scientists to the extension officer to the farmer. It emphasizes acquiring knowledge, creating awareness, and disseminating new technologies through extension and communication techniques, with weak efforts at upgrading skills. The system has been slow to create a cadre of agricultural professionals who provide technical and professional services, such as diagnostic services for plant and soil health, farm management services and who enhance farmers' technical and entrepreneurial skills so they may make more informed decisions about their practices.

Almost all the states and provinces have recently recorded dramatic reduction in the absorption rates of agricultural graduates in government service. This signals higher education that graduates must gain knowledge and learn skills applicable to the private sector, in addition to the knowledge and skills required for self-employment. Because students enter agricultural education based on the field's employment opportunities, India's agricultural education system must undertake a continuous workforce study and workforce assessment concerning market needs as it develops and reforms its agricultural curricula.

Curricular Innovations

India's agricultural education curriculum must become more skill oriented, interweaving quality assurance throughout its curricular processes. In this way, graduates are more likely to satisfy the current market demands with their high degrees of capability in handling modern-day management systems. Moreover, graduates' expertise, in the course of time, will enable the agriculture sector to harness and use resources and other inputs efficiently, thereby converting the dimension of comparative advantage into competitive advantage through quality improvement and cost minimization. In recent years, higher education has introduced some curricular advances to achieve these goals.

In 1995 the Indian Council of Agricultural Research launched an innovative project for Agricultural Human Resource Development with the World Bank's financial support. (World Bank, 1995). The project's mission has been (1) to improve the quality and relevance of higher education in agriculture, and (2) to strengthen the capacity of participating states to develop and manage their agricultural human resources. Significant achievements of the project's phase one include the following:

- the creation of an Accreditation Board to establish norms and standards for higher agricultural education;
- uniform academic regulation;
- examination and evaluation systems for the SAUs;
- revision of the undergraduate course curriculum (see Table 1);
- improvement of faculty competence;
- provision of sabbatical rules;
- reduced inbreeding through the allocation of 15 percent and 25 percent seats at the undergraduate and postgraduate levels, respectively in all SAUs for students from other states;
- selection of assistant professors through the National Eligibility Test (NET);
- awarding scholarships to those students willing to move out of their home states; and the
- creation of databases for workforce needs.

Encouraged by the project's success, ICAR is preparing to initiate the project's Phase 2, which would cover all the states and the SAUs.

India's Agricultural Curriculum

To prepare for agriculture's diversification, value addition, and globalization, higher education in India must strengthen its agricultural programs in those areas and disciplines to improve the quality of education and to achieve excellence in student performance after graduation.

Multiple Needs for Reform

To expose students to such current issues as post harvest and storage technology and problems in marketing agricultural produce, for example, it was necessary to revamp the undergraduate agricultural education, making sound this all-important curricular foundation.

Globalization urges higher education to develop a long-term strategy to modify the educational system to continuously be a viable player in the highly talented and competitive international market (Mukhopadhyay, 1997).

Changes in the Agriculture Industry

The changes in the agricultural industry signal the need for changes in the agricultural profession, which, in turn, present a need for higher agricultural education to prepare graduates in new and innovative ways. The changes in the industry and the profession (Government of Tamil Nadu, 1999) are shown in Table 1.

Table 1. The Changing Agricultural Scenario

Past	Present and Future
Controlled market Liberalized market	Era of increasing production Era of productivity and sustainability
Striving for self sufficiency Individual farming	Striving for trade and income generation Corporate and cooperative farming
Operating at local level	Operating at national and international level
Majority employer is the government	Majority employers are private sector companies and nongovernmental organizations
Government actively participates in agricultural activities	Government facilitates agricultural progress
Demand for farm graduates	Demand for job opportunities
Emphasis of ag education is on extension	Emphasis of ag education is self-employment
Introduction of more degree programs	Consolidation of courses and degree programs
Education provides technical knowledge on agriculture	Education creates an all around agricultural professional
Need for agricultural scientists	Need for agricultural managers
Low career mobility and options	Increased career options

Chances in Higher Education

To provide the profession with technologically savvy, business minded, well-rounded graduates, higher education institutions have gradually shifted from being agents of the government who discharge traditional educational functions as a social service to becoming key players in the knowledge industry with direct social responsibilities. The dimensions of higher education that have transformed to 21st century demands are shown in Table 2 (Government of Tamil Nadu, 1999).

Table 2. Paradigm Shifts in Higher Education

System Dimensions	Present	Future
Institutional Nature	Traditional pattern of education	Characteristics of knowledge industry
Mode of Education	Formal	Informal; networked
Funding Source	Single	Multiple sources
Academic Orientation	Disciplinary	Inter-disciplinary and trans-disciplinary
Stakeholders' Influence	Students, faculty, staff, and government	Employers, community of users
Curriculum Development	Rigid procedures; Sole responsibility of the academic community	Dynamic process; Participation of all the major stakeholders
Accountability	Government and other regulatory bodies	Market/client accountability; Customer orientation
Institutional Culture	Static and adherence to established norms and procedures	Change oriented; flexibility emphasis
Alliances	Individual institutional operations with very limited alliances	Several collaborative alliances with a variety of institutions in the country and abroad

Inherent Problems

In addition to macro-level changes, agricultural education faces a range of problems at the micro level, which are listed below.

1. **Narrow range of skills.** Graduates who are trained in a limited range of skills cannot meet market demands.
2. **Unemployment and underemployment of graduates.** Agricultural institutions must reorient the curriculum to produce graduates who bring relevant skills to the market.
3. **Students with urban background.** About 70 percent of the students in India's agricultural universities are from urban areas. Such students not only lack prior exposure to field conditions but are often not willing to work in rural areas.

Table 3. Profile of Agricultural Graduates

Knowledge	Skill	Attitude
Agriculture/education as a science	Entrepreneurial skills	Interest in agriculture profession
Resources required for agriculture & its management	Communication skills	Willingness to work in rural areas
Technological aspects of agriculture	Leadership skills	Ambition to take up agriculture/vet farming
Production and protection aspects of agriculture	Interpersonal skills	Self-reliance and self-confidence
Integration of agriculture with related sciences	Management skills	Systems thinking & analytical approach
Environmental aspects and wasteland management	Technical skills	Information-seeking
Advanced technology and advanced applied science	Project management skills	Competitive spirit
Knowledge on international as well as local agriculture	Organizing skills Resource management skills	Adaptive spirit Proactive and positive

4. **Inadequate program flexibility and diversity.** Agricultural universities must move from being passive participants in the national and international markets to active trendsetters.
5. **Brain drain.** Increasingly, agricultural graduates are employed in non-agricultural sectors because of few employment opportunities in agriculture. This diminishes the investment in these graduates' training and represents a loss of workforce to the sector.

In addition, adequate and appropriate infrastructural facilities are essential to attain international standards. Developing an excellent network to facilitate interaction among the various stakeholders is crucial for the university to understand the market needs and demand.

The curriculum review process should be rigorous and systematic, with clear visualization of the goals and values in mind. While formulating the syllabi, ICAR took care to ensure that the resultant curriculum can produce graduates with the knowledge-skill-attitude profile, shown in Table 3 (Government of Tamil Nadu, 1999).

India's Revised Agricultural Curriculum

The revised undergraduate curriculum, shown in the following list, displays a thorough agricultural management thrust. It includes content in courses about information technology and decision support systems, irrigation methods and management, quality crop production methods, sensible mechanization, and wasteland utilization. Students learn about field consultancy in technology transfer and project formulation. They study farmers' organizations and how their membership enhances bargaining power. Other course content includes transgenic plants, new seeds and nursery technology, precision farming, protected agriculture, and horticulture.

Table 4. Revised Agricultural Curriculum Requirements for Undergraduates

- Agribusiness Management
- Agroindustries
- Biodiversity
- Bioenergy
- Biofertilizers
- Bioinformatics
- Biopesticides
- Bioresources Technology
- Biotechnology
- Commercial Agriculture
- Contract Farming
- Environmental Sciences
- Experiencial Learning
- Food Processing
- Food Technology
- High-Tech Horticulture
- Hybrid Rice Production
- Information Technology and Communication
- Integrated Nutrient Management
- Integrated Pest Management
- Intellectual Property Rights
- Marketing
- Mechanization
- Natural Resource Management
- New Computer Applications
- New Food Product Development
- Organic Farming
- Plant Genetic Resources
- Post-harvest Technology
- Precision Farming
- Protected Horticulture
- Rural Agricultural Work Experience
- Sustainable Farming
- Tissue Culture
- Value Addition
- Water Management and Water Use Efficiency

Curriculum Content Revisions

The revised course curricula accommodates in the new content, areas of agribusiness, export, diversification of agriculture, integrated pest management, integrated nutrient management, biodiversity, environmental science, biotechnology, geographical information systems, computer applications, biostatistics, and intellectual property rights. It also added specialized courses in agriexport business, quality control, value addition and product development, market trends and intelligence, world trade agreements, trade-related intellectual property rights, global convention on climate, biodiversity, and diversification.

Three areas addressed in the curriculum revision are particularly pertinent to India's unique needs. They are biotechnology, the environment, and sustainability.

Biotechnology. Biotechnology offers enormous benefits to the Third World, especially in solving the problems of poverty, hunger, disease, environmental destruction, and natural resources development. Biotechnology is more relevant to a country similar to India than to the industrialized nations of the west. India has no dearth of priorities—the tremendous pressure of its rising population, poor sanitation and drinking water, the premium on cultivatable land, the vagaries of the monsoon, fuel shortage, and forest devastation. Hence, training students and generating a skilled scientific workforce in the biotechnology field are imminent.

Environment. The previous agricultural curriculum paid minor attention to global environmental problems and negligible attention to local conditions. Addition of environment to the curriculum has become vitally important in building rural, rural-urban and urban networks.

The revised curriculum promotes student understanding of local cultures and their effects on the natural environment. Students research how nature and culture interact and how these interactions have created local landscapes. It is hoped that this curriculum design will develop graduates whom farmers in developing nations will find more acceptable in extension training venues.

Sustainability. The concept of sustainable development encompasses not only environment but also poverty, population, health, food security, democracy, human rights, and peace; all critical issues in developing nations.

Sustainability is, in the final analysis, a moral and ethical imperative, in which cultural diversity and traditional knowledge must be respected.

All content areas, including the humanities and the social sciences, must be involved in addressing issues related to environment and sustainable development. Addressing sustainability requires a holistic, interdisciplinary approach that brings together the different disciplines and institutions while retaining their distinct identities.

The revision process considered local, regional, and national contexts of sustainable development. By introducing field experience into university classroom teaching, ICAR hopes such development will receive greater attention in the future.

Pedagogical and Administrative Reforms

To compete in today's market, the agricultural human resource must be self-motivated, be solidly professional in his or her practices, display a strong work ethic and attitude, and demonstrate adequate, technical business-communication, computer application, and management skills. Generating graduates with such traits and skills is at the heart of the curriculum revision process. The hope is that the SAUs will, in time, provide the agriculture industry with a competent breed of technology agents, who become job creators, ultimately strengthening the industry and the nation.

The higher education administration and faculty will implement the revised curriculum through the following approaches:

- faculty development,
- industry-institution linkages,
- interinstitutional collaboration at national and international levels,
- resource mobilization and utilization,
- rural work experience,
- distance learning,
- modular courses for skill and entrepreneurial development, and
- accreditation at national level and cross-country accreditation for continuous improvement in quality of education.

Rural Agricultural Work Experience. Experiential learning in agricultural education largely helps graduates who will seek self-employment in commercial agricultural regions. It also helps to produce, highly competent and well-trained students who have developed technical skills and managerial capability that the agriculture sector requires and needs (Macadam and Packham, 1989; Bawden, 1978; Bawden and Packham, 1991; Kannaiyan, 1999.)

The major objectives of the revised curriculum's Rural Agricultural Work Experience (RAWE) are:

- to develop self confidence among students (Kannaiyan, 1998);
- to develop an insight into the availability of local resources;
- to gain practical experience in farm operations;
- to find out the existing indigenous knowledge of practicing farmers and its significance to the technological generation of new agricultural graduates;
- to study the local market network for planning agricultural production;
- to study leadership in action and its role in agriculture and rural development;
- to collect information about the potentialities and prospects of agro-industries;
- to study village-level functions, its organizational structure and the responsibilities of different departments;
- to study the attitudes of farmers about adopting newer crop production technologies;
- to collect information on various constraints to the farmers; and
- to study the structure and functions of regional research stations and their roles in solving regional problems.

Scientists and project leaders of various research projects brief RAWE students on the latest technologies and location-based scientific knowledge. This exposure to location-specific research helps students to observe and ask questions so they learn more from the field experience. Students travel to a particular village and stay with one family with a tiny farm and one family with a small farm, and one family with a large farm through the RAWE session.

Distance Learning. This century's new information technology has liberalized and liberated the learning process (Abdul Kareem, 1999). Open learning offers flexibility in admissions, learning methods, course content, examinations, and even evaluation (Ranga Rao, 1999). Further, the audiovisual elements of distance learning ensure greater uniformity in teaching quality. Finally, distance learning circumvents the problems of time and space for learners.

This form of learning has immediate applications in extension education for technical officers in agricul-

ture, horticulture, agricultural engineering, and rural home science. It also breaks down the barriers that exist between stages of education—primary, secondary, tertiary, and higher education.

Entrepreneurship Development. Some important entrepreneurial characteristics that graduates who opt for self-employment must develop are the need for achievement, greater intrinsic motivation and reinforcement, self-reliance, and independence. The agricultural curriculum promotes entrepreneurial development by encouraging students' creative and innovative response to the environment (Kannaiyan et al, 1999). Some entrepreneurial activities geared for graduates are:

- Biofertilizers and biopesticides production and sales
- Consultancy
- Landscaping
- Mushroom production
- Nursery management
- Ornamental gardening
- Seed production, processing and sales
- Sericulture
- Waste recycling for value-added products
- Waste utilization, such as composting

Accreditation. Quality assurance and institutional and program improvement are the two main purposes of accreditation. Institutions may seek accreditation for the institution as a whole or for specific programs or departments within the institution. All over the world, various national and state agencies conduct accreditation as a regulatory process. However, voluntary accreditation of educational institutions, as carried out by various accrediting bodies is a uniquely American process.

In India the concept of assuring quality in higher education is relatively new. Past concerns about standards have now shifted to quality. Several national organizations are already functioning in relation to assessment and accreditation of institutions of higher education. For example, the National Board of Accreditation of All India Council of Technical Education is a statutory body that deals with such professional disciplines as engineering, management, and pharmacy studies. Another organization, established by the University Grants Commission, is the autonomous National Assessment and Accreditation Council, enforces the mandate to judge and assure quality in liberal arts, sciences, and other disciplines. Similarly, the Veterinary Council of India looks after the accreditation of Veterinary Education.

The Indian Council of Agricultural Research created an Accreditation Board, which plays a key role in maintaining the norms and standards of agricultural education (Padda and Maurya, 1999; Kannaiyan, 1999). The ICAR developed a self-study report mechanism, which it suggested to agricultural universities. The participating SAUs report relevant curricula in agriculture and allied sciences based on the needs and requirements of the students. They also report ways they attain excellence in education and ways they produce highly competitive, vibrant agriculture graduates and technocrats.

A Call for Ongoing Curriculum Reform

For India's agricultural production to grow and meet the consumption demands of its growing population and to exploit any and all export possibilities, the agriculture sector must make certain key policy decisions and adopt innovative approaches and strategies in the years to come.

The roles of the agricultural universities and the national agricultural education systems must become more pronounced and they must become more accountable for (1) producing skilled graduates, and trained extension personnel, and (2) guiding governmental agencies in their policy making processes.

India's Future Realities

Ongoing reform of the agricultural education syllabus must address all of the following eventualities, which India will soon witness:

Agriculture will become knowledge based and apart from traditional farmers, corporate entities and agriculture professionals will take up modern, scientific farming.

Demands will increase for enabling such services as information on weather, pests, cost-effective nutrient and irrigation management and global demand and price information for different commodities.

Demand will increase for facilities such as scientific storage of all kinds of diverse agricultural commodities, safe transport of these and market infrastructure.

Trained scientists and a skilled work force will compete globally.

If new technologies are to become acceptable to practicing farmers in the shortest possible time, extension approaches must involve widespread farmer participation in technology development and adoption strategies.

Services of non-governmental agencies will grow, apart from the public extension agencies, state agricultural universities, and farmers' science and training centers.

Globalization of agriculture will put pressure on land use decisions and ultimately the commodity mix.

India's Imminent Demands of the Agriculture Industry

As a result of these future realities, this developing nation will call upon the agriculture sector for solutions:

Implement a clear objective and a detailed strategy to increase food-grain production, first, intensely in favored areas, to meet the basic food demands of India's rising population.

Diversify agricultural production in less-favored areas, first, by developing these degraded lands and later, by planting semi-irrigated seasonal, annual, or perennial crops to effectively manage the available moisture-irrigation-water potential.

Augment and strengthen efforts on resource conservation and proper utilization through the latest technologies.

Generate and adopt technologies harmonious with the environment and manage by judicious combination of local and traditional technologies with modern technologies, such as chemical fertilizers and pesticides, biological fertilizers and pesticides, irrigation water, and biotechnology.

Implement natural resource management programs, such as watershed development, especially in erosion-prone areas.

Strengthen production, conservation and eco-restoration forest development activities.

Resultant Policy Recommendations

Higher education institutions that offer agricultural curricula are advised to establish an ongoing evaluation of their programs to match current market demands and progress.

Continue curricular emphasis on agriculture management for quality agri-businesses.

Build the value system in students to respect practicing farmers who have low or moderate levels of education and tend deteriorating resources, yet must meet the challenges of dealing with such diverse institutions as industry, finance, and co-operatives.

Support hands-on training, which generates greater confidence within students for accepting positions in the corporate sector or for self-employment.

Support experiential learning as the first step in personality development and values development in agricultural students.

Strengthen the education system by asking stakeholders for feedback (1) on the capabilities of the graduates the universities have produced and, (2) on the sector's changing needs that may instruct further curricular reform.

Devise a periodic mechanism for a strengths-weaknesses-opportunities-threats (SWOT) analysis to enable the system to adjust for changes.

Provide in-service training for faculty to encourage capacity building.

Routinely investigate infrastructure needs to acquire the latest equipment and instruments for effective teaching and learning.

Modernize the library systems with computer networks.

Build accountability into system processes at all levels.

Examine cross-country accreditation to make graduates internationally mobile (Harish Kumar, 1977; Kannaiyan, 1999; Chandrasekaran, 1999) .

Continuously modify the methodology of commercial agricultural courses to make them parallel with the realities of the emerging modern scenario.

Add course modules that prepare students to write viable project proposals for setting up any entrepreneurial ventures and for seeking funding from financial institutions.

In summary, curriculum development is a continuous process that must consider the learning needs of the present-day generation of students. Because learning is a lifelong process, a training extension curriculum must also attend to the needs of the practitioner in the field. Agricultural education curricula must address the here and now of the agriculture industry on the local, national, and internationals markets in this 21st century.

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References

Bawden, R.J. 1978. *Experiential Learning Concept Introduction*. School of Agriculture and Rural Development, University of Western Sydney, Hawkesbury, Australia.

Bawden, R.J. and R.G. Packham. 1991. "Improving Agriculture through Systemic Action Research." In: *Dry Land Farming: A Systems Approach*, Sydney: Univ. Press, Sydney.

Chandrasekaran, M. 1999. "Global Imperatives for Reorienting Agricultural Education in India." In : *Quality Agricultural Education Management*, TNAU Publications Series 20. Publication Directorate, TNAU, Coimbatore. 17-21.

Government of Tamil Nadu, 1999. *Manpower Need Assessment for Agricultural Sector in Tamil Nadu,* Study Report Prepared by TATA Consultancy Services, Chennai.

Harish, Kumar, 1977. "Globalization of Business Education." *University News*: 35(2) 10-11.

Jain, H.K., 1999. "Agricultural Education since Independence: Lessons Learnt and Strategies to Strengthen Education, Research and Extension in Universities." Paper presented in the *International Symposium on Agricultural Education in the Next Century: Lessons Learned and Prospects*, held at New Delhi, India.

Kannaiyan, S. 1996. "Experiential Learning." In: **Agri-business**. Eighteenth convocation, Tamil Nadu Agri. Univ., Coimbatore, Tamil Nadu.

Kannaiyan, S. 1998. "Experiential Learning System in Agricultural Education." Paper presented in **Seminar on Teaching, Research and Extension Methodologies**, Univ. Agrl. Sciences, Bangalore, Karnataka.

Kannaiyan, S. 1999. "Reorienting Agricultural Education in the context of Globalization of Agriculture." In : *Export orientation - A strategy for Indian Agricultural Growth,* edited by A. Abdul Kareem and C. Ramasamy: 151-168.

Kannaiyan, S. 1999. *Experiential learning system in Agricultural Education in University Agricultural Education Management*, edited by Kannaiyan and others P.87-96.

Kannaiyan, S. 1999. "Accreditation for Quality Agricultural Education." In: *Quality Agricultural Education Management*. TNAU Publications Series 20, Publication Directorate, TNAU, Coimbatore. 278-283.

Kannaiyan, S., KA. Ponnusamy, M. Chandrasekaran, and M. Chinnadurai. 1999. "Entrepreneurial Development for Professional Agricultural Graduates in Quality." In: *Quality Agricultural Education Management*. TNAU Publications Series 20, Publication Directorate, TNAU, Coimbatore. 308-319.

Kareem Abdul, S. 1999. "Information Technology and Knowledge." *University News*, 37 (42): 16-19.

Macadam, R. and R.G. Packham. 1989. "A Case Study in the Use of Soft Systems Methodology." *Agricultural Systems*, 30: 351 367.

Mukhopadhyay, M. 1997. "Globalisation Imperatives for Indian Education Sector." *University News*, 35 (8): 1-2.

Padda, D.S. and N.L.Maurya, 1999. "A New Accreditation System for Quality Assurance of Higher Agricultural Education in India." Paper presented in the *International Symposium on Agricultural Education in the Next Century: Lessons Learned and Prospects,* held at New Delhi, India.

Paroda, R.S., 1999. "Revisiting Land Grant System of Agricultural Education Need for its Reorientation," Paper presented in the *International Symposium on Agricultural Education in the Next Century: Lessons Learned and Prospects* held at New Delhi, India.

Paroda, R.S., 2000. "The Cutting Edge of Science." *University News*, 38 (32): 13-19.

Rao Ranga, C.S., 1999. "Reaching the Unreached Experience of the Open University." *University News*, 37 (42): 3-5.

SAR, 1995. Document of The World Bank. **Staff Appraisal Report India, Agricultural Human Resources Development Project**. March, 9, 1995. 166.

Meeting the Challenges, Making the Changes

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GCHERA should be proud of its achievements since its founding; in particular, the efforts to share knowledge and support people's learning. That's not what most people among the six billion people in the world experience. And that number is still growing. According to recent projections, the seven-billion mark will come slightly more slowly, but it will be here by 2014. And our people will be poorer. Most will be in the low-income or low- to middle-income group. This creates huge and growing income gaps. One-sixth of the world's people produce 78 percent of its goods and services and receive 78 percent of the world's income, an average of $70 per day. Three-fifths of the world's people in the poorest 61 nations live on less than two dollars a day, which is six percent of the world's income. An unimaginable one billion plus live on less than one dollar a day.

The Challenges

Further, we have problems in social living standards. More children in low-income countries are dying before age five. Only three out of four children who begin primary school are still attending four years later. Even if they enroll, they are not staying long. Adult illiteracy is unacceptably high, particularly among youth—fifteen- to twenty-four-year-olds—and even higher for women. Even more disturbing, the target date for 100 percent participation, set at the Education for All Conference in Dakar in 2000 is 2015, and yet 75 million children still will not be attending school then. Two-thirds of those not in school will live in sub-Saharan Africa.

Another factor contributing to the growing gap in living standards is the HIV-AIDS pandemic. More than 22 million have died—18 million in Africa—and now HIV-AIDS is spreading through Asia. Thirty-five million men, women, and children are living with HIV-AIDS; 95 percent of them are in developing countries.

Can we work together to reduce the numbers in extreme poverty? In my opinion, this is the fundamental challenge of the 21st century. How can we lift people out of extreme circumstances which are actually worsening? Did we make any progress in poverty over the past ten years? The target was to halve poverty rates by 2015. In fact, overall poverty rates have been relatively stable. The rate today is roughly the same as it was in 1987. The regional picture is varied, and we do have some success stories, particularly in Asia, East Asia, and the Pacific. South Asia, home to the largest number of the world's poor, decreased four points to 40 percent. In almost all other regions, poverty increased.

Education and Development

This modest and mixed progress is in spite of all our global targets and goals, good rhetoric, and international efforts. At the OECD-United Nations-World Bank Conference in Paris in 1998, the international development community set goals, which were reported on in "A Better World for All," presented last year at the World Social Summit in Geneva. The report said we are not doing so well.

Development's strategy placed education in a key position—at the heart of development. Education can have a direct impact on reducing poverty. First, if people in poverty gain more knowledge about agricultural technology, child health, and so on, they are more likely to ease their circumstances. Second, the human capital accumulated through learning and more education can lead to greater overall productivity, which, in turn, results in economic growth. And third, when we learn to cooperate and respect one another, we develop social capital. One likes to think that educated people would be nicer to one another and look after the poor in their communities. And we do see some of that.

Education's Role

However, education is necessary but insufficient for success; it is not the universal panacea that everyone seems to think it is. Unless the national governments

have a sound macroeconomic environment, an effective labor market, and a political context free from corruption, learning is not supported, and therefore, cannot bear fruit. National and local governments must work together to put this set of optimal conditions in place.

The public policy question is critical: How can we in the global community support these endeavors and add value to them? What should *we* do? We must work with people to help them identify and take their next strategic steps, which are to:

- provide access to relevant learning and quality teaching;
- make wise and fair investments in their people; and
- build sustainable institutional capacity.

The responsibility of basic education clearly lies at the national and local government levels, so we must include this key supportive global activity in our work with countries.

This is particularly so for the changes urgently needed in countries' curriculum and assessment systems, especially in secondary schools. At present, these systems largely provide outmoded, outdated, "old-colonial," and essentially context-free curricula with totally inadequate conditions for learning.

Reforms in Education

What should *they* do? Nations must prepare for a range of potential futures and radically revise their secondary school curriculum to ensure that students acquire essential learning areas and core competencies and attitudes. The curriculum must offer flexibility so students can get in and out easily over time.

Interestingly enough, I have found that all countries, developed and developing, know this, and they have adopted, more or less, the same goals:

1. Everybody wants quality education and training systems.
2. Everybody wants to provide every student with learning experiences relevant to the individual's current and future needs.
3. Everybody wants to stimulate the country's economic and social development. They know that educated people, knowledgeable citizenry, and a skilled workforce make this happen.

The bottom line is that we all want to improve learning achievement, particularly for young people, but also for adults adapting to new situations throughout their lives.

We know that education makes a difference. We know that individuals who have acquired relevant knowledge and skills—including skills that help them to keep on learning throughout their lives—are likely to be more productive, be better off, have healthier families, have smaller families, and be caring of one another and the environment.

What Nations Need. Countries not only have more or less the same goal, but they are all asking more or less the same questions now:

- How do we deal with the numbers, especially the increase in demand for secondary and tertiary education?
- How do we include everybody? The poor, the marginalized, rural, girls, disabled, indigenous, and so on—how can we provide an education system for absolutely everyone?
- How can we pay for it all? Everyone is wrestling with the role of government, especially the pro vider/funder issues. Should government provide and fund everything or only fund it and have other people provide it? Or can some entity serve both functions?

Sharing knowledge on how countries in similar circumstances have tackled the problems they faced, the difficulties they overcame, and the results they reached is another key intervention for the global community.

And, current trends make this a very urgent goal—a growing imperative—within a rapidly changing context. Global capital moves in microseconds; global trade is growing. Technology changes information flows and communication modes. More than one hundred countries now have democratically elected governments, twice as many as a decade ago, accompanied by decentralized decision making. Market economies now prevail in countries, accounting for 80 percent of the world's population, which is 30 percent higher than a decade ago. Governments are rethinking their roles, and the private sector is becoming more involved.

Faced with all of this, countries need more highly educated and skilled populations, and individuals need more skills and information to compete and thrive. How can we run a democratic country? How can we run a market economy? The provision of a good education system where people learn the "right" things is therefore critical. The prerequisite in tertiary and higher education and research for all of us is that a good basic foundation must be in place. The stakes are very high. The choices countries make now will have

very long-term ramifications. Those who respond astutely will make progress, and those who do not will fall even further behind. The gap is widening. All nations—developed and developing—are wrestling with these questions.

A Case Study. In my own country, New Zealand, for example, we were faced with a languishing economy with many people who were unemployed, including many unemployed graduates. What surfaced was some sort of mismatch between what employers needed and what universities produced. In reaction, we reformed the entire public service, the education system, and the curriculum. The latter was done through a massive consultation exercise; we actually asked all New Zealanders— residents in the country and everyone else worldwide: What is it you want children to know and be able to do when they leave school?

The curriculum framework shown in the chart below is the result of that consultation exercise.

People told us they wanted essential learning and content, but they were happy to leave the details to the professionals. They knew what essential learning areas they wanted, but they wanted each to be very broad. They also wanted essential generic skills. They wanted graduates to communicate. They wanted graduates to work numbers, be literate, and solve problems. They wanted them to manage their own lives; be social, cooperative, and helpful to one another. In a nation of great rugby teams and cricket teams, physical skills were high on their agenda. And they wanted work and study skills. They introduced values and underlying principles too.

The New Zealand Curriculum Framework

- **Principles**
- **Values**
- **Essential Learning Areas**
  - Language and Languages
  - Mathematics
  - Science
  - Technology
  - Social Sciences
  - The Arts
  - Health and Physical Well-Being
- **Essential Skills**
  - Communication
  - Numeracy
  - Information
  - Problem Solving
  - Self-Management and Competitive
  - Social and Cooperative
  - Physical
  - Work and Study
- **Assessment**

So parents and employers knew exactly what they wanted the schools to provide, and yet the schools were not providing it. Interestingly enough, many other countries, including Australia, have done this exercise. Even though the exercise was conducted in different ways, the results were very similar sets of essential skills.

The Implementation Process. Because people are often resistant to change, I have found that securing effective change requires a number of ingredients.

1. The public needs to feel there's a crisis. Throughout the implementation of New Zealand's reforms, it was not difficult for the public to perceive the educational system in crisis, especially after we initiated the consultation exercise.
2. Develop a national comprehensive strategy. David Lange was our Prime Minister, and he made himself the Minister of Education. With his supervision, the implementation of reforms went smoothly.
3. Work for political will and public consensus. In New Zealand our consultation exercise led to our curricular reforms, and public input resulted in consensus.
4. Secure the right financial and legal framework. Nations must find or obtain extra money to make such reforms.
5. Acquire the right people to implement the strategy. Because we reduced the public service by two thirds, most of the chief executives left. The new executives were younger, better educated, and more diverse, i.e., women, members of minority ethnic groups, and those under 40.
6. Have resources and incentives for educators. Reforms will not be successful unless people have what they need to get the job done and receive recognition and rewards for doing their best.
7. Establish purposeful partnerships with business and industry. No government can do this massive work alone.

Lining up that mix of seven ingredients is not easy. And despite the lessons learned in New Zealand, I can assure you there is no simple prescription. No "one-size-fits-all" manual exists to show a country how it can progress toward the long-term goal of universal

access to a good basic education and the opportunity to acquire advanced skills. We do know, however, about three core changes that make a difference:

- The players must focus on results. Managing inputs is important but pointless, if they do not know where they want to be.
- The players must know their starting point and what progress they make along the way toward achieving the results. It's very important that countries have a solid information system to gather and store good statistical data, track learners' achievements, and allow comparisons.
- The players must have opportunities to increase their management capacities. They should be encouraged, for example, to join international organizations. Then, decentralize both responsibility and resources to them. People must have the money to carry out their responsibilities. Too often in times of reform, resources are not there.

Decentralization. Involving local players allows governments to make better choices. Decentralizing responsibility is an effective route to good decision making and corruption deflecting. In a village in Tanzania, for a case in point, I was involved in a school project with a community education fund where decentralizing was very effective. The community provided their share of the expenses up-front to build a school. The whole village sat around from the beginning of the school's construction to the end. They watched the contract signings, and the contracts were even nailed up on a tree for all to see. Everybody watched to see if the money was spent properly.

Decentralization is an area of knowledge in which many countries have developed interest. They seek details of case studies describing systems that have experienced positive results after decentralization. In systems that have undergone reform and decentralization, parents, students, nongovernmental organizations, entrepreneurs, and communities have become more proactive. Rather than passively receiving services from the education sector, they are now actively involved, injecting their opinions and etching out roles in the provision and delivery of education.

Decentralization offers many opportunities for the private sector. Given that no government can afford to provide education for all people during their lifetimes, decentralization becomes a win-win situation, provided governments ensure the quality and standards. The government's role is becoming more facilitative and regulatory in nature, and the private sector is the active implementer within social sectors. The private sector has increased its tertiary provision through distance and open learning, for example.

What can *we* do? The global community can play a key role by sharing knowledge with countries and systems about decentralization and its possible costs, potential benefits, advantages, and disadvantages.

Known Successes. We can also share reforms for which data show effectiveness and cost-effectiveness:

- Interventions with high returns—basic education for girls and the poorest children.
- Preventive interventions—early childhood development; school health.
- Innovative delivery—distance education; open learning; use of new technologies.
- Systemic reform—setting standards; improving governance; private sector involvement.

Support from International Agencies. Another way forward is to work with key agencies such as The World Bank and the International Monetary Fund. They have set two priorities for action—expanding debt relief and helping countries develop poverty reduction strategies.

Much money from such agencies as The World Bank, IMF, UNESCO, UNICEF, DFID, UNAIDS, Oxfam, Soros, and others will flow to debt relief. These agencies have targeted the 40 highly indebted poor countries for meeting two key goals in improving social standards: educating everyone and bridging the digital divide. These funds are reserved for education and health, so we can assist by helping these targeted nations form advocacy groups that will monitor how the funds are spent and how the funds benefit their people.

Obstacles to Progress. If we know all this works, what's hampering the progress? We can pinpoint some common constraints:

- **A lack of political will.** Not all decision makers see quality education as a top priority. And in many disciplines, people just do not know how to tell the story. They do not know how to reach the minister of finance, and they do not have a common message. Without the political will that puts education at the top of the development agenda, change is impossible. From this global consortium, we should each leave with key messages that we can offer every time decision makers ask us what on earth they can do.
- **Highly centralized structures.** These structures are very costly and less than effective but may already

be in place. They, however, keep power out of the hands of those who know the most about their local constituency and feel the most concern for their welfare.

- **Incentive systems.** Teachers, principals, and bureaucrats are rarely held accountable for their performance. The educational system must expect this accountability and have incentives in place from the start of the reform implementation.
- **Resources.** The very basic resources the educational system needs are often lacking, very poorly allocated, or actually not allocated at all.

Financing Reforms. What is clear is that no one group or agency can do any of this alone. We must move forward on all three fronts—government, the private sector, and sources of external financing, i.e., the international community. If we just look at spending on the government front, most of the money will come from public monies earmarked for education. Private spending, which includes students, parents, entrepreneurs, employees, and other nongovernmental entities, will generally contribute about 25 percent. For developing countries' spending, external financing makes up only two percent, and of that, funds from the World Bank are 0.6 percent.

Although external financing is such a small percentage, it often is the only discretionary money a government has. It has significant leverage and is yet another key intervention on the part of the global community. However, external financing from developed nations has unfortunately dropped worldwide with only four countries—Denmark, Norway, Sweden, and The Netherlands—meeting the target of 0.7 percent of the GNP.

Collier and Dollar (1999) reported that donors can double the poverty reduction efficiency of their aid by targeting poor countries who are pursuing good policies and institutional environments.

Nobel Laureate Sir Arthur Lewis said, "The fundamental cure for poverty is not money but knowledge." Just as I said about education alone, money is necessary but insufficient for success. Having the right policy and institutional environment is critical. Harnessing the energy and expertise of the private sector is important so everyone is involved in the process. Sharing knowledge, case studies, profiles, and writing scenarios about how this can be done and where it's been done successfully is another key intervention on the part of the global community.

Because everything is linked to everything else, it is not enough to stay in a single, preferred discipline. We must craft the right public policy environment if we actually want to accomplish anything in any discipline —whether it's agriculture, technology, or any other. Take the Internet, for example. It provides access to global databases of knowledge, resources, and many learning, employment, and entrepreneurial opportunities worldwide, but it requires infrastructure and affordable rates for connectivity. And, what's the reality for the developing world?

A digital divide exists, and we can see this in the share and cost of Internet access. Africa's share of the worldwide Internet-access pie, for example, is miniscule in comparison with other world regions. This data is from 1999, so since access is growing even faster now than it was then, Africa's percentage is probably slightly lower for this year. Another negative factor is that Internet costs in Africa are much higher than other parts of the world. Internet access in Africa has grown rapidly. As of July 1999, 53 of the 54 countries had Internet access in their capitals. Most capitals have more than one Internet service provider. Moreover, Internet costs are still very high as a percentage of a nation's per-capita GDP—for example, 1.5 percent for Australia and 107 percent for Uganda. Now what developing country can afford this even if it manages to secure connectivity?

To obtain Internet connectivity, a nation must have the following contributors to access and affordability: (1) deregulated telecommunications and competition; (2) good regulatory framework; (3) wireless options; and (4) community connectivity centers. They probably should provide separate provisions for education so the schools acquire better access. Connectivity also requires various levels of technical and use capacity and key players who understand the value of Internet access for development goals.

A Shift in the Development Assistance Paradigm

Just to solve this one issue alone is going to require very different approaches, understanding, and ways of working. It cannot be business as usual. What we apparently need is a shift in the development assistance paradigm for this century. We need a different way of working.

Several decades of development assistance have shown the limitations of knowledge transfer based on policy blueprints. What works and what does not work are highly dependent on the country context, so we must address specific needs rather than general blue-

prints. The development solution ultimately resides in the countries themselves, whether developing or developed. Yet, sharing in the right way national and regional knowledge, global experiences, lessons learned, and effective practices definitely helps.

What do I mean by "the right way?" I mean the integration of the activities of all players into what I call a "community of practitioners." The players include not only ministries of education and other partners but also the communities, the private sector, some international organizations, and some nongovernmental organizations (for-profit and nonprofit)—whoever the country needs to help solve the problem. And, if two or more players are not typically speaking to one another, for example, the country can provide pressure from outside if it uses the other players strategically.

The community of practitioners must develop a two-way knowledge flow. Traditionally, few knowledge exchanges take place between rural, indigenous groups and the central government, for example, or between external partners and the country clients.

Learning must be two-way and reciprocal. We at the global level tend to think that we know what countries should do, and we act as if we cannot learn much from them. Yet, in fact, achieving this level of change is a case in which people often do have to reinvent the wheel in their own country. They must implement it, and they must be thorough. We in the international community can assist them in doing it more quickly.

To create this shift in the development assistance paradigm, the nation needs a joint design of development solutions which requires: (1) a community of practitioners; (2) strong knowledge partnerships; (3) learning through two-way knowledge sharing; and (4) change in culture.

I have an example. Brazil's Ministry of Education came to the World Bank, where we assembled a set of international education specialists and institutional specialists. We met for three days to look at Brazil's education issues and our issues and then to formulate a solution. What do they need? Who do they need? Do they need money? How can we help to reach that solution?

The objective is to create an environment where partners learn from one another. They engage in a joint learning exercise. Everyone brings something to the table and takes something away. In this example, Brazil gained access to international expertise, and The World Bank gained a case study it can share with others for training purposes.

This type of learning exercise requires adjustments in culture and behavior within people and institutions. The participants need:

- a high level of trust;
- interaction of people across organizational boundaries;
- tolerance for mistake making and not knowing;
- diversity of perspectives; and
- rewards and recognition for knowledge sharing and collaborative work.

This shift in the paradigm is not about technology. It is about people talking to each other, listening, learning from one another, and building joint theories, policies, and solutions.

Today we see many potential applications. We have the Caribbean Education Knowledge Network, School Networks, WorldLinks, global gateways, and virtual universities in Mexico and Africa. GCHERA is an example as well.

The challenge before us is to redefine the boundaries of our institutions and change our culture and behavior; to strengthen knowledge partnerships; and listen, learn, and grow together. In meeting this challenge, in making these changes, we will create environments that support learning whatever discipline and acquiring essential skills for that unknown work in the unknown future.

For me, education is about producing people who can run their own lives, run their countries, and create a peaceful, prosperous, livable world. And that's the curriculum for the 21st century—for all of us.

African Universities Today and the University of the Future

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Higher education has become increasingly popular in many African countries. This coupled with rapidly increasing population has put higher education at a crossroads. To meet the demands of students and the employment market, many countries have diversified the education systems to increase the available options. In addition, increased sensitization to the importance of higher education has led many countries to put the highest emphasis on education leading to expanded higher education systems. These and many other factors in Africa have caused an upsurge within the past ten years in the number of universities.

Kenya's Higher Education Enrollment

Kenya had only one university for nearly twenty years, the University of Nairobi, which was originally inaugurated as the Royal Technical College. Now Kenya has six state universities, ten private ones, and many others yet to be registered. This growth has also been observed in Uganda, Tanzania, and the rest of Africa.

Kenya's Current Higher Education Capacity

Despite the massive enrollment of students, these universities have not satisfied the number of students qualifying for university education.

The table below shows we had more than 173,000 students in 1999 sitting for what is called the Kenya Certificate of Secondary Education (KCSE), an examination that qualifies students for university entrance. Out of this number, only about 30,000 qualified. In 2000 more than 182,000 students registered for this examination but only about 40,000 earned the minimum university entry requirement, a C+ and above.

Admission 2001–2002	**Admission 2000–2001**		**% +/–**
KCSE Year	**2000**	**1999**	
Candidates registered	182,805	173,792	+5.19%
Candidates with C+ average and above	40,491	30,666	+32.04%
State Universities' capacity	10,000	10,000	flat

Students who meet requirements for university entry make up a very small percentage of the number of students who actually sit for the KCSE exam. Of the more than 40,000 qualifying students, the six state universities together have room for only 10,000 students. The Kenya government sponsors those students.

Hence, only 25 percent of qualifying students are sponsored; the remaining 75 percent are left out. This 75 percent may enter private universities, parallel degree programs, foreign universities, or not attend any higher education institution.

Foreign universities and neighboring countries have aggressively advertised their degree programs to capture the attention of our unadmitted students. These include universities in India, Australia, Britain, and the United States.

Growing African Nations' Higher Education Systems

African nations hope to open more universities. The foremost reason is to provide higher education to more of the student population. Because the government can give limited financial support, it must seek monies to support and sustain any new universities.

African nations give little attention to the university of the future. To set up standards for the university of the future, we must first look at the challenges facing our existing universities, including any shortfalls in the present systems.

Our challenges are fundamental and will not disappear anytime soon. They include:

- Lack of facilities to provide quality education caused by insufficient government funding. African governments have more pressing issues to address, such as security, poverty reduction, and primary and tertiary education to eradicate illiteracy. Kenyans consider it better to have more people who can read and write than have Ph.D.s.
- Poor remuneration for resource people leading to few qualified lecturers. Across the borders, universities may offer better salaries and working conditions which results in brain drain or brain exportation. This drain flows elsewhere in the African continent and outside it.
- Unaffordability of incorporating and sustaining new technologies. Some countries cannot yet afford to even teach biotechnology, let alone practice it. Most African countries are unsure of how information technology will affect higher education, especially teaching methodologies and courses offered on-line. Many professors are used to the chalk and blackboard, not PowerPoint or dot-com teaching.
- Few technology facilities for better acquisition and access to information are in place. Keeping up with how fast technology changes is also an issue. In Africa we learn the marketplace has released a new version of the software program we use, but upgrading these programs is very expensive. We cannot afford the new version. The universities in Africa might, therefore, have the computers, but their students may be using obsolete programs.
- Stiff competition for quality students because all universities offer the same courses.
- Some universities experience government and political interference and control. In Kenya, for example, we may wake up one morning and our government instructs us to double student intake. We must do this without more resources or improving the infrastructure. With the political instabilities in our countries, any politician who wants to gain mileage on his ideologies will come to the universities to seek support. One day the students are fine; the next, they are on strike supporting the politician and his ideology.

The Mission of the University

Most universities had a mission when they were established. For example, the mission for Jomo Kenyatta University of Agriculture and Technology (JKUAT) is as follows:

- To provide directly or indirectly or in collaboration with other institutions of higher learning facilities for university education (including agriculture, scientific, cultural, technological, and professional) and integration of teaching, research, and effective application of knowledge and skills to the life, work, and welfare of the citizens of Kenya;
- To participate in the discovery, transmission, preservation, and enhancement of knowledge and stimulate the intellectual participation of students in the economic, technological, agricultural, professional, and cultural development of Kenya; and
- To play an effective role in the development of agriculture and technology in conjunction with the industry and to provide extension services to contribute to the social and economic development of Kenya.

In our mission we had the community in mind. We also needed to create an environment of critical thinking for our students. For us to achieve the mission, however, we must have substantial finances to remain focused.

My university's mission is similar to others within Africa. Universities also offered specific degrees; for example, Kenyatta University was mandated to offer education degrees. Egerton University would give degrees in the agricultural sciences. The University of Nairobi had several, including medicine, veterinary medicine, and social sciences. Moi University's degrees were to be community health and technology. JKUAT, where I am, offered degrees in engineering, architecture, and agricultural sciences. Due to financial constraints, competition, and privatization of higher education, along with the employment market dictating which types of courses they required in graduates, most universities tend to offer degrees now that were never in their original mandate.

Today Kenyan universities are very diverse in their offerings. JKUAT is probably the only one still focused on its original mission. The University of Nairobi offers 29 academic programs. Kenyatta University is thinking about starting a school of medicine. Maseno University is the newest university. It offers about everything that other universities do

and so does Egerton. This diversity, however, means a duplication of courses which constricts existing resources.

Outside Kenya, in East Africa, immediately after independence, the University of Dar-es-salaam in Tanzania was the only university offering degrees in Law (and they were high-quality degrees). Makerere University in Uganda offered medical degrees and the University of Nairobi, degrees in veterinary medicine. Each country now offers all the courses society demands. In all countries, unplanned courses of study spring up to satisfy the needs of society.

Most African universities today aggressively advertise themselves. Maseno University advertises itself as the only university in the world situated on the equator. Students get excited at that idea, and they apply to Maseno.

At JKUAT we attracted more students by changing the names of some programs. We no longer offer a degree in Surveying but in Geomatics. Agricultural Engineering is now Biomechanical and Environmental Engineering. We also introduced competitive courses which has raised our status among other universities. A good course may have few applicants because students just do not know exactly what they will do once they finish the degree.

Parallel Degree Programs

Due to limited financial support from the government, universities have been forced to offer income-generating courses commonly known as parallel degree programs. Fee-paying students in these programs sit in the same classes as government-sponsored students. Evening classes are also offered so students can work during the day and attend classes at night.

These programs have had a very positive impact on the running of other sectors of their universities. For example, now the universities are able to retain highly qualified faculty members who are well focused and competent. Finances from these extra fees go to improve faculty payment packages.

With the haphazard introduction of these fee-paying programs, however, increases in campus populations have choked the water systems, sewage systems, and residential accommodations, overstretching university facilities, which are now inadequate and limited.

The University of the Future

Different countries have different concepts of universities and how they perceive them. They may view the university as a center of progress; a research community; an educational environment; a center of excellence and higher education; or a center that prepares people for the job market.

In my view the objectives of a future university should be:

- to provide quality higher education in market demand-oriented disciplines, flexible enough to change with the times; capitalize and specialize also on our university's strong points;
- to adopt a more creative and effective use of modern technology;
- to sensitize the personnel on the importance of excellent professional skills;
- to provide for the diverse needs of students. For example, we should give the students what they want, i.e., more applied courses not just theoretical ones. For example, instead of agriculture, we should advise them to enroll in agribusiness with a marketing option;
- to focus on measures to raise funds for the university in a sustainable manner in order to improve services, remuneration, and retention of qualified staff;
- to introduce entrepreneurial studies to make the students self sustaining, self employed, and innovative; and
- to provide an effective and welcoming learning environment to produce not only educated scholars but also highly disciplined and practical citizens.

Any university that can concentrate on staff development, improvement of teaching, research, and management will have achieved the best organizational technique for the university of the future.

The university of the future can be organized along the following lines:

- **Institutionalization.** Create institutes, schools, or colleges within the universities to give new dimensions to the learning process and to implement diversified programs. By creating schools, we could offer a higher diversity of degrees and manage them independently.
- **Flexibility of courses.** The university of the future should offer competitive courses. These courses should be flexible enough to allow students to:
  - — take academic leave and be readmitted to continue after one or two semesters or years. This is more important with fee-paying programs. A student may not have enough fees and should be permitted to work first, get money, and come back to continue.

  - — move from one degree course to another related degree course with credit transfers. Most students do not know what is involved in a particular program, and sometimes they change their minds even after one year of study. They should be allowed to change into another course of their choice.
  - — move from one university to another with credit transfers. This allows students to shop around, and universities should struggle to excel to retain students.
  - — to be admitted during any semester of the academic year.
- **Rationalization of courses**, in which a student taking any course is exposed to the same curriculum and facilities in any university within the nation's higher education system. This may be difficult because each university advertises its uniqueness, and claim to add something extra into their curriculum.
- **Diversification of courses.** The universities will offer degree courses geared toward employment market requirements. The courses should also satisfy the students' and the community's needs and requirements.
- **Facilities.** The university infrastructure should be well planned with sizeable and well-equipped lecture rooms with proper acoustics. Laboratories should have modern equipment with facilities to analyze and finalize data. Accommodations should include hostels with recreation facilities, counseling services, and hospital facilities, enabling all students to have the same learning environment with equal opportunities. Facilities should allow for both students and staff to increase their efficiency through research activities. Facilities should also not be limited to physical buildings but could include farms and hospitals within the community.
- **Research initiatives.** Research in universities should be without question a chief priority. There is a need to formulate competitive research programs in every university. The research should be of high quality to attract funding from national and international sources. Research will stimulate lecturers to improve their output, and keep them in contact with other researchers through publishing, workshops, conferences, and collaborations.
- **Research-based community training programs or outreach activities.** Jomo Kenyatta has an outreach program where we invite women farmers to come to learn new technologies in agriculture. These women then go back to their farms or villages and pass along this information. Through such community training, universities can regain public trust.
- **Linkages** with industry, research institutions, and policy makers to translate research information and innovations into products, tools, and language that rural communities can understand or use. Previously, research findings have been very difficult to implement. This type of collaboration will facilitate the movement of research information to end users and other stakeholders.
- **Accessibility of university information.** The concept of virtual universities is yet to become popular within the African continent. Virtual universities and distance education would have been the best option in the absence of physical facilities. However, the limiting factor has been the lack of physical contact between the learner and the resource person. On-line learning also exposes the learner to unnecessary information. In some African countries, evening classes are more popular and information is available regardless of age or status. In Kenya now our ministers even attend evening classes because they want law degrees.
- **Collaboration.** Collaboration should be encouraged with industries and research institutes both nationally and internationally. These will lead to improved curriculum designed to meet the demands of the job market. International linkages could support research and provide exposure for new changes. Staff will also have improved professional skills and knowledge. It can give staff opportunities for sabbatical leave and staff exchange programs.
- **Diversity of students.** Providing a diversified university education system will produce diversified students that will meet the needs of their society. And this is important because the needs of our society are also quite diversified.
- **Student attachment programs.** These programs should be enhanced to improve networking and relations with possible employers as they will know what the students are capable of and improve student changes of employment and training. At JKUAT we have established a center of excellence because of these student attachment programs. Three-quarters of the students in Kenya applied to come to JKUAT because the name of the university sells us. They know they will be attached to these particular programs, which will increase their chances of employment.

- **Cost of university education.** Universities should strive to provide higher education at a low cost, so that it is available to the majority of students. Universities could reduce the cost of learning by starting income-generating ventures that would sustain low-cost programs.
- **Monitoring mechanisms.** A system should be established to monitor the quality of education, efficiency, and management, which should include student and staff evaluations, not presently used in Africa. Each employee should also have a job description.
- **Gender.** The universities should offer equal opportunities to men and women. Currently, in African universities, women student or staff population is only 30 percent. Those in the sciences may be only 14 percent. Women must learn science because scientists are the implementers of new technologies. Most farmers in Africa are women. If they do not learn science, they will miss new technologies unless they are educated. Even in the house, our wives and husbands must know science and labor saving technologies because they do not know how to operate the microwave. They must also know how to work out their workspace.
- **Autonomy.** The state should not interfere with education systems unless it either is checking on the quality of education or providing funds.

How will we know if the university of the future is successful? The following should be our criteria.

1. The university will have made a name as a reputable center of excellence that is at the forefront of intellectual activities. Our graduates must be proud of their university.
2. Increased enrollment of student participation. Most students admitted will have chosen this university because of what it offers. The students will be eager to learn, eager to get high technology exposure, and most will be employed soon after graduating.
3. Qualified academic staff who are highly motivated, sustain a competitive employment criteria, and retain their seniority.
4. Increased high-quality publications especially in highly rated journals and increased innovations that are patented.
5. Excellent facilities equipped with advanced technologies.
6. Promotion of a balanced education system. For example, such a system should not promote science programs at the expense of social and cultural disciplines but at the same time allow for diversity and free choice.
7. A review of curriculum at least every four or five years to get rid of obsolete degrees and specialize in areas where we have an advantage.
8. Form interdisciplinary networks within the region and beyond.
9. Proper planning and management.
10. Increased cooperation with industry for funding and innovation implementation.

As we go back to the Green Revolution, let us also "green" our academic programs and universities. For the universities already at the level of the university of the future, consider there is still room for improvement, yet encourage and support those below that level through giving and sharing.

Through stimulation of thought and ideas, and through collaboration, more blessings will come your way.

Stimulating Local Communities through Global Collaboration

Richard M. Foster
Vice President for Programs, W. K. Kellogg Foundation
Michigan, USA

In Amsterdam two years ago when the Global Consortium for Higher Education and Research in Agriculture first met, I expressed that, while we came from a variety of different regions of the world, we shared similarities. A few that I mentioned were:

- a need for universities to be part of the very fabric of the societies they represent;
- a need to connect people and communities who depend upon universities for knowledge resources for their daily lives and the betterment of their lives;
- a need for increasing economic and social options in agriculture and food systems, while preserving natural resources and the economies of communities; and
- a need to be connected worldwide to take advantage of this vast array of resources represented within GCHERA.

GCHERA should be proud that its growth from about 30 institutions to about 388 individual and institutional members from 136 countries certainly demonstrates that we desire to be connected worldwide.

The W. K. Kellogg Foundation

The Kellogg Foundation has been interested in agriculture, food systems, and rural development for most of its seventy years. Kellogg is known for its grants, which the Foundation offers in the United States, throughout Latin America and the Caribbean, and in Southern Africa, from Mozambique south. The Foundation is pleased, for example, to be a partner in Peter McPherson's project for Ending Hunger in Africa. My position with the Foundation is the vice president for food systems and rural development in the United States.

Initiatives in U.S. Food Systems

The Foundation's current work in U.S. food systems covers three major initiatives. First, integrated farming systems looks at communities' responsibility for growing food that is economically viable for small- and large-scale agricultural production. The systems are environmentally friendly and socially responsible.

Another initiative is food systems professions education. We asked land-grant universities: Are your graduates prepared to engage in a very volatile food system during the 21st century? The answer in 1993 was no; they were not prepared. Over the project's seven years, universities around the country have achieved better communication with the people they serve and the partnerships they have.

The third initiative is the most recent. Over the next five years, the Kellogg Foundation will spend about $50 million in the United States on Food and Society. A food and environmental stewardship program, it promotes food, nutrition, diet, and health, involves food and agricultural and community sustainability, and advances in food science and technology in higher education.

Kellogg is also exploring a potential program about investing in community-based food enterprises. How do we add value back into our rural communities so that rural residents can make a living and remain there? We must find ways to create viable livelihoods in rural areas. In doing so, we would promote the growth and well-being of communities, and we would stem the migration to the cities we have in the United States.

Kellogg's Underlying Principles

Kellogg provided about $70 million in grants for food systems over the past eight years, and about $50 million in rural development—representing the largest funding source in the country in those areas. Our commitment is to maintain, if not strengthen, and increase that commitment over the next several years.

Community Impact. The Kellogg Foundation uses two under-girding principles in its work. First, we are

a community-impact foundation. That is, for all the money we give, we ask the question: How will this grant improve the lives of children, families, and communities? Kellogg, however, granted $40 million of the $70 million I mentioned to land-grant universities. Yet, the Foundation is not building capacities at universities for its own sake. We're building capacities at universities to help people in communities.

Serving People. Second, we believe that, if an institution doesn't serve people, it has no value. We do not fund traditional research but rather the application of knowledge to solve people's problems. That definition applies to outreach, the expression of making this wonderful knowledge resource capacity of institutions available and transparent to people who have needs.

Instead of speaking about globalization, I prefer to use the term *globalizing systems.* Globalizing systems are economic—they are food systems; they are trade; they are distribution. Most globalizing systems, though, benefit a small group of people who already have resources. We know that, through globalizing systems, many people receive no benefits.

So, how do we take advantage of having this global network while we serve people at the local level? I do not believe that our responsibility is to increase the net worth or shareholder value of multinational organizations, but I do believe it is to improve the value of people and community.

The Charge of Universities of the Future

We have good evidence that GCHERA members are collaborating and coming together as a consortium. We arrange faculty and student exchanges; we share coursework through technology-based classrooms; we work together on degree-sharing programs—and we have plenty of listserves! There are many positive examples.

Yet, we must ask ourselves: How do we bring these examples of progress in collaboration to scale? How do we make the example the common occurrence? How do we make the exception the current practice? How do we make collaboration and resource-sharing commonplace? And how do we use this consortium to increase our capacities to strengthen our responsiveness to local constituents?

Someone said that it takes energy and resources to change. But my contention is that it also takes energy and resources to stay the same. And we're in dire circumstances if we stay the same. So how do we devote the energy and resources we have in GCHERA institutions to move agriculture and food systems forward?

The Land-Grant Model

In the United States, we have the land-grant system of universities. First established in 1862, these institutions took fifty years (to 1914) to lay the foundation for being the knowledge-based learning organizations they are today. And they have obviously evolved since 1914. But between 1862 and 1914, they were sites of tremendous arguments—What is extension? What is research? How should we position them? What should be the connection between research and teaching? These universities' journeys to the kind of knowledge systems they exhibit today were extremely difficult.

While most land-grant institutions are tied to a state or another geographic region, they still represent what we at Kellogg consider the principal models of university engagement for the future. They have internalized the key components of a knowledge system and they've made these components available to people who, in turn, use them to better their lives.

The Foundation believes that, because land-grant universities are the most appropriate models of higher education for the future, some aspects of this system may be applicable to other GCHERA members and institutions. Consider that universities of the future:

- must be part of the social fabric of a nation;
- must use their tremendous knowledge resources to help people at all levels be successful;
- must contribute to social and economic development; and
- must be responsive to both the large-scale industrial economy and the smaller-scale local economies.

In short, universities of the future must be nation builders and view their work from a community perspective, as well as a national and global perspective.

Demands for Change

In 1995 the Kellogg Foundation sponsored a seminar on the future of higher education. Our colleagues from South Africa indicated they were dismantling their higher education system because it was inconsistent with the society. The system remained focused on the elite, even though the nation begged for educated people who could build a new nation that valued

justice and equity. The system was based on historical perspectives of segregation instead of on future visions of diversity and inclusivity. They were tearing down the system to build a new one.

Our colleagues from eastern Europe indicated they were revamping their higher education systems, which were based on political ideology rather than higher-quality academic standards. Their systems educated only a chosen few. To rebuild eastern Europe, the nations needed universities that would prepare many.

Colleagues from the United States indicated that it was time to think about higher education from a perspective different from research. Many, although certainly not all faculty members, believed that it was time to look at different organizational structures based on engagement. For the past forty years, research had been the only organizing structure available to the universities. In their major public and private universities, a faculty member's research activity determined his or her record for compensation, tenure, or advancement in rank. Research determined the faculty's and the university's current and future value.

Large government expenditures fueled research projects that focused on global impact, sometimes in strengthening economic advantage worldwide. Many times it improved production, which gave us an economic advantage because we were fighting a cold war.

What happened in 1989? The wall came down, the cold war was over, and federal funds dried up. Many of our institutions queried: What now? What are we to do with this industrial model we put together for information and technology?

What we have since learned is that, while the nation was attending to higher priorities, social and economic issues were tearing apart our local communities in the United States. And now we look with hope to higher education to address this need.

Research and Outreach

We now live in an era in which we can—and *must*—do both research and outreach. We can engage in good research and reward those who do it best. We can have good outreach, making our institutions a significant part of the social fabric within which they apply their knowledge resources to the problems of people.

Outreach as an organizing structure has some unique characteristics. At a conference three years ago at The Ohio State University, then-president Gordon Gee asked: If you were a top-ten outreach institution in the 21st century, what would you look like? Five of the responses follow.

1. Perhaps programs would be based on societal needs identified by public constituencies.
2. Perhaps research would be based on public needs, and the test of value would lie in its application to solving problems and meeting social requirements and social needs.
3. Perhaps students would not be just those on a central campus, but those who live and work in the communities the university serves, and those who have remote access to relevant university programs.
4. Perhaps faculty members receive rewards or incentives based on a variety of criteria, including research, outreach, and teaching, as it related to meeting societal needs.
5. Perhaps rewards would be based on the best contributions of faculty, not on narrowly perceived criteria that applies generally to research, teaching, and outreach.

In a study we conducted at the University of Nebraska in 1991, we posed the question of whether or not there was differential rewards for research, faculty engaged in research, extension, and teaching. The vice chancellor at that time, who is now retired, replied, "Of course not. We reward all of our people equally for the contributions they make."

Let me share with you the brief results of this study. We recorded the three-year salary increments for each faculty member in the University of Nebraska college of agriculture. We indexed the average salary as 100. So that anything above average would obviously come above the line at 100 and anything below that average would be below 100. You might assume that equal numbers would appear above and below.

The highest faculty rating over a three-year period was 147 percent above average. The lowest was about 74 percent below average. Looking at the primary responsibility of each of those areas revealed: (1) in the high end with about 110 to 147 were researchers; (2) those in the middle group with about 110 to 90 were teachers; and (3) everyone with below 90 were in extension.

Not surprisingly, the administrative response was, "We never knew."

The college did change its faculty reward system. Their administration's remediation was requesting

faculty members to use a scholarly method to show and measure their best contribution to research, teaching, or extension, and they agreed to reward it.

So, using this study and its results as an exemplar, can we do that at our universities? Can we only look at the faculty's best contributions to the university's mission, and yet acknowledge that some researchers do not work well with students, some professors do not belong in the laboratory, and some extension personnel interface better with practitioners than with young adults or academics? We must utilize our personnel, our human resources, the best we know how. Granted, it requires collaboration and integration, but we must start with the advantages each individual brings.

Reconfiguring the University Structure

How do you prepare yourselves and your students to be global learners yet locally responsive? I believe the university of the future will be built on multiple structures—a research structure for determining quality but also an outreach structure. If we do not embrace outreach, we may be cast aside. We may become the Jurassic Park of universities, where people go to see the extinct.

The old ways of thinking about the three functions will be recast into how we handle information and knowledge:

- *Discovery* will replace the term *research.*
- *Application* is in line with *extension* and *outreach.*
- *Transference* will be *coursework* and *degree-granting programs*.

I truly believe we'll have this transformation. The integration of discovery, application, and transference—all ways to handle and manipulate knowledge and information—will focus on the result instead of the input.

The university's function will transform as well; that is:

- to discover new information and combine it with old information, giving it new meaning;
- to apply new knowledge to problems and reorganize knowledge in ways never thought of before; and
- to teach "students" how to learn in a new society based on knowledge, information, and learning.

What does this all mean for our institutions? What will it mean for our participation in this consortium? I suggest six concepts to consider as we collaborate with one another in the future:

1. Use your faculty and institutional colleagues from around the world to glean the best science-based information as the underpinnings of your curricula and do not solely rely on what is locally available. Make your teaching programs relevant for both local communities and their participation in a global society. Teach your students to be global learners, but teach them how to apply what they learn to their local situations to make their own lives and their own communities better.
2. Develop collaborative research programs that make use of the best minds in the world. Use the technology to connect with fellow institutions and faculty members that complement your own. Insist on applications of the discovery that address your local and national needs, and resist the impulse to participate in global congresses from which you gain no greater benefit than a refereed journal article. Expect more from yourselves.
3. Develop your technology infrastructure, and use it to bring in resources more than to export them. Do not be taken advantage of. Can you connect to major libraries and knowledge databases through technology that enhances your research, teaching, and outreach? Can you connect your students and faculty to key resource people around the world? Can you use the technology or collaborative learning for both faculty and students? You should be able to do all of these activities.
4. Use technology to expand your base of influence. Use technology and the power of an outreach structure to have a more positive influence on people.
   - Can you reach more than just 18- to 22-year-olds?
   - Can you reach and serve the needs of people as they transition through key life stages from birth to retirement? Through career changes? Through technology changes?
   - Can you reach them where they live?
   - Can you serve people in their communities without their coming to you?
   - Do *they* always have to learn on *your* terms?
5. Develop a reward and recognition system that encourages your faculty to do their best in whatever area they excel as their contribution to the mission of the university. Reward the best teachers, outreach specialists, and researchers for their unique contri-

butions. Do not try to make them what they are not. Take advantage of their strengths. We need all these functions but we need them collaboratively and in an integrated manner.

6. Open your institutions for public inspection and participation. Conceding that isolated institutions will be sitting ducks, the power of technology rests in the hands of the people in communities. They have the ability to shop around anywhere in the world to get information technology—and they will. So how do you open up your universities?
   - Use public advisory and policy committees to help you set research and outreach agendas. Don't rely just on your faculty members who say they have a network. Bring that network inside.
   - Build collaborative partnerships with businesses and civil society organizations.
   - Use businesses and communities as your classroom and as your research laboratories. Listen to all voices, especially those that are rarely heard and rarely come to the table.
   - Most of all ask the public what is important.

We know the world is rapidly changing. Information and knowledge is power, and technology is putting it more and more in the hands of the people. The way that we react to the new learning and organizational society will determine if we become a global resource for the discovery and application of knowledge or just part of a problem that, in time, will be circumvented.

This consortium can help us in moving in that direction. We must be relevant institutions of higher education in food and agriculture. We must prepare the next generation of leaders for a very volatile 21st century in food production, land use, and environmental sustainability. We can meet these objectives because we're in that era of not *either/or* but rather *and/both.*

We in GCHERA are in the very early stages of defining who we are. Let's use our imaginations. Use the innovation and quality of our faculties and our partners back home to determine the future role and successes of this distinguished consortium.

Time Has Come for the Consortium to Move Forward

Martin C. Jischke

President, Global Consortium of Higher Education and Research for Agriculture

President, Purdue University

Indiana, USA

At this wonderful and informative conference, we have had many interesting and very stimulating presentations and discussions. If we have learned anything in these past two days, it is this: we in GCHERA have much to do if we are to tackle these issues of global food security and environmental sustainability.

We do have far to go, yet we have made great progress in recent years. We have completed a foundation on which we can build.

The issues we discussed here literally stretch across the entire globe. What affects each of us affects all of us. We face many of the same challenges. I was struck by how often I could easily translate our speakers' references to circumstances in their countries to issues I face day by day in Indiana at Purdue University. I am sure others had similar reactions.

What We Learned

As the world's problems touch us all, the solutions must involve and evolve from us all. We surely *can* learn from one another. The importance of the issues makes clear that we *must* learn from one another. And we have learned much in the past two days.

First, we learned that a need clearly exists for an international organization such as GCHERA. People in agriculture, higher education, and research must work together to play a pivotal role in gaining food security and environmental integrity.

Second, we learned that globalization holds increased importance on our campuses, in our curricula, and our research agendas for our students. Globalization makes the type of cooperation that, at least in principle, is possible through an organization such as GCHERA, absolutely central to the future.

What We Must Do

As our universities—and, in particular, universities with a strong agricultural emphasis—plan for tomorrow, they need the capacities that a global consortium such as ours can provide.

While I believe we have had a good beginning in GCHERA's first two years, for this organization to sustain itself over time, we must ask harder questions about what it is we are going to do together. Can we mount programs that justify our organization's existence? Can we justify the commitment of time and energy that participation at such a conference entails? Each of us is very busy with many important responsibilities. Can we shape programs that encourage more individuals and other institutions to participate?

First, I urge us to continue our discussions about the global context within which our universities operate and about the sharing of information and experiences. This conference, as was the conference in Amsterdam, has been very successful in this regard. Our discussions have been enormously valuable.

Second, we have confirmed that an awareness of international issues is immeasurably enhanced by the opportunity for people to study together in other parts of the world. We must find ways to expand exchange programs and other opportunities for students, faculty, administrative leaders, and university leaders to come together to talk and learn from each other. One of our major challenges is gaining financial support for such programs.

Third, the nature of our research agenda, including both the intended and unintended consequences of globalization and the opportunities that come with breathtaking new science and technology, is changing. We have common cause in these issues. Initiating ongoing discussions of how our curricula will evolve and how our research agendas will shift seems to be a very ripe area for us. It includes discussing the scientific basis of food safety regulatory issues; the changing nature of the economic circumstances that drive this global agriculture we are a part of; and certainly the potential and the concerns associated with modern genetics and genetically modified organisms. In all of these issues, we have a consistent interest and can learn from one another.

Our Common Voice

Maris O'Rourke said that we should develop some messages to carry with us from this meeting to share with those with whom we work. Such messages can begin to give GCHERA a common voice. I suggest five key messages we hopefully can apply to the work we do:

1. Food security, on the one hand, and environmental stability, on the other, are challenges we must tackle simultaneously. No food security is possible if the production of food causes the environment to deteriorate. Food security by definition is a long-term issue that we can only achieve through environmentally sound means.
2. Solutions absolutely require global collaboration. Environmentally, we know that what takes place in one part of the world can have an enormous effect halfway across the globe. In a real sense, we are all downstream of each other. When it comes to feeding the world, global cooperation is essential for progress.
3. Effective visionary leadership is key in accomplishing the work that awaits us. I believe it was Einstein who said, "First, an idea." Those ideas come from people, people of vision. Those of us here must step up and provide leadership. Just as importantly, we must develop new leadership—broader and more inclusive leadership.
4. We have much to learn from one another. As universities, as representatives of the private sector or government, we must share our knowledge and our viewpoints. We must see the world from others' perspectives. We cannot bring about change by staying the same ourselves. We cannot bring informed leadership to these issues without ourselves first understanding this larger world. This notion of broadening the community of interest and the boundaries of our institutions seems to be absolutely essential.

Maybe the most important message is number five.

5. Research and education will be the key elements for success. Higher education, of course, plays a special role in successful futures, but all of education does. We have the human capacity to teach future generations. We have the capacity for long-term impact and change through education of tomorrow's leaders. They surely will be the ones who will ultimately solve these problems.

I leave this conference optimistic and buoyed. I believe the world is changing—for the better. I am optimistic that Peter McPherson's hope for a renaissance is, in fact, a real possibility. We are entering an age not only of greater understanding of others and ourselves but of our environment and the tools available to us. We can use science and technology properly and safely to tackle the world's food problems, but we must be willing to take a few steps:

- We must bring our institutions together, cooperating on collaborative initiatives.
- We must share resources, ideas, and knowledge.
- We must work to increase understanding between people and between nations.

Two years ago in Amsterdam, I said that people with a dream founded GCHERA. It is a dream of a world that is not filled with contradiction and conflict, but a dream of a world that is filled with cooperation and collaboration.

Every time we meet and talk, share thoughts and ideas, and then go home and hopefully apply what we have learned to our work, the dream comes closer to reality.

On a more personal note, I thank you for the wonderful opportunity, honor, and genuine pleasure of serving as the first president of this new organization. I have truly enjoyed working with you. I have learned a great deal. Your enthusiasm has energized me and made me more optimistic about our future. You have influenced the universities at which I have worked. I thank you for everything you have done and continue to do. I certainly look forward to working with you even more in the years ahead.

Future Perspectives for Global Consortium of Higher Education and Research for Agriculture

Dmytro Melnychuk
President-elect, Global Consortium of Higher Education and Research for Agriculture
Rector, National Agricultural University
Ukraine

> *The best wealth in the world is people communication*
>
> *Antoine De Saint-Exupery*

Dear First President of the Global Consortium of Higher Education and Research for Agriculture, Dr. Martin Jischke!

Dear Participants and Guests of the Second Global GCHERA Conference!

Dear Ladies and Gentlemen!

I would like to begin my short message by expressing my great appreciation to the members of the Executive Committee and the members of our Consortium, and all those who entrusted me with this high mission of being the GCHERA President-Elect in Amsterdam in 1999. Now, I am honored and happy to take over the Presidency in this paradisal city–San Francisco. Taking this opportunity, I want to assure you that I will contribute all my knowledge, experience, and efforts to justify your hopes with important and interesting activities within the framework of our global organization, which has already gained high authority.

I would like to address my special thanks to Dr. Martin Jischke. Ten years ago, when I came to the United States for the first time, Dr. Jischke and his colleagues had to have great courage to believe in me and sign the Memorandum on Cooperation between Iowa State University and National Agricultural University of Ukraine as a result of my two-hour visit.

Today I am honored to declare on behalf of the faculty and staff of NAUU that thanks to our close collaboration with a number of partner-universities, supported by the World Bank, USAID, USIA, FAO, UNESCO, European Union, and other sponsors, my university has taken a big step toward reforms in all its activities and became one of the founders of GCHERA. Thank you very much.

Taking this opportunity, I would like to address my special thanks to the Director of Rural Development of The World Bank, Dr. Robert Thompson. There was a time when we had excellent student exchange programs organized both for the National Agricultural University of Ukraine and Purdue University. At that time Dr. Thompson was Dean of the School of Agriculture. I also highly appreciate his considerable contribution to reforming agriculture in Ukraine while being President and Chief Executive Officer of Winrock International Institute for Agricultural Development. Please, accept my thanks and best wishes for success at your current position of the highest importance.

I address my special thanks to Dr. Lavinia Gasperini who represents here such a prominent and important organization as FAO and Dr. Richard Foster, Vice-President of W.K.Kellogg Foundation, and all our sponsors for supporting our initiatives.

The Work of GCHERA

The mission of the Global Consortium of Higher Education and Research for Agriculture (GCHERA) is absolutely important for humankind. I believe that in having our worldwide international cooperation developed, we will be able to solve the food security and environmental challenges confronting our world.

As you may know, according to the FAO data, every sixth man in the world starves or has a pathological lack in nutrition. It is up to one billion people. By the evaluation of this prestigious organization, if Ukraine can fully realize its food production potential, it will be able to provide food for almost one billion people. So, there is a question: How much other unused potential do we have worldwide? These facts should

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Austria
BOKU University of Agricultural Sciences, Vienna
University of Veterinary Medicine, Vienna
International Institute for Related System Analysis

Belgium
Gembloux University;
Ghent University
Katholieke Hogeschool Kempen, Geel

Bulgaria
Stara Zagora Zooveterinary Institute

Great Britain
Edinburgh University
Scotland Agricultural College

Netherlands
Wageningen University and Research Center

Germany
Humboldt-University of Berlin
Hohenheim University, Stuttgart
Dresden Technical University
Leipzig University;
Hannover University
Anhalt University of Applied Sciences
Weihenstephan University for Applied Sciences

Poland
Warsaw Agrarian University
Krakow Agricultural Academy
Shetsyn Agricultural Institute
Agricultural Academy in Lublin

Czech Republic
Czech University of Agriculture, Prague

Hungary
Debrecen Agricultural University

Italy
Peruggia University
Biophysical Institute of the National Research Center

Slovak
Slovak University of Agriculture, Nitra

ASIA

China
North-Western University (Jan-Ling)

Israel
"Mashaw" International Association (Tel-Aviv)

Cambodia
Agricultural Institute, Phnom-Penh

Republic of Korea
Korean University, Seoul

NORTHERN AMERICA

USA
Iowa State University, Louisiana State University, Pennsylvania State University, Purdue University, Case-Western Reserve University, University of Nebraska-Lincoln, Chicago State University, Minnesota State University, North Carolina Universiy

Canada
Toronto University

AFRICA

Egypt
Zagazig University

encourage all of us to continue our extremely important activity that is so necessary from both local and global prospects.

In this context, I would like to remind you, my dear colleagues, a folk wisdom that is generally held in my country. It says: "We pay our deep gratitude to a man who gave a piece of bread to starving people, but we pay the deepest gratitude and remember for ages, passing from one generation to another, the memory about a man who gave people knowledge about how to get food by themselves." We build monuments to these outstanding men, devote books to them, and award them with the most prestigious awards and prizes.

Establish Close Relationships with International Organizations

All the issues we are discussing now are considered as key directions in activities of such highly regarded international organizations as The World Bank, FAO, UNESCO, WTO, EU, USAID, USIA, and many others. I am completely convinced that having support from these international organizations, our Global Consortium will make a great contribution into this activity. We can use our organization to work directly with our youth and the intellectual elite of each nation.

We have the extremely important tool in our hands– the programs of study and curricula–to train highly qualified professionals in various fields. Using this tool efficiently, we will have the best chance to realize successfully those recommendations developed by FAO, UNESCO, and other international and local organizations in our countries through the universities. Thus, I consider it to be in the best interest of GCHERA to establish and develop close collaboration with these international organizations.

GCHERA's Working Group on Developing Recommendations for Global Curricula and Programs of Study

(Bachelor, Specialist, and Master Degrees)

Agronomy
Plant Protection
Soil Sciences and Soil Chemistry
Agroecology and Environmental Studies
Forestry and Landscape Architecture
Horticulture
Land Resources
Animal Sciences

As a matter of fact, Dr. Jischke and I set such a purpose about six years ago. Today we can observe the positive results of this work, first of all, in the developing countries and countries with economies in transition. At the same time, important reforms in higher agricultural education have been provided by a number of universities in developed countries as well. Numerous international conferences on global issues in higher agricultural education and research, held annually in the United States, Europe, Asia, Latin America, or Africa, can show the changes in education systems towards globalization.

Thus, we have accumulated a great experience in globalizing systems of higher agricultural education and research throughout the world. Now is the time to start systemizing this experience and knowledge, and make certain important conclusions for the future. I believe that the GCHERA leaders will form working groups of highly skilled professionals for each area of science. Members of these working groups will work out and introduce for discussion through the Internet their common recommendations for programs of study and curricula on relevant majors. These recommendations could include the best teachers' and students' books, software with programs of study and technologies (including technologies of distance education, extension, biotechnologies, problems of agriecology, quality and safety of agricultural products on the world market), and centers for international short-term trainings.

Recommending a Global Curricula in Agriculture

I think, for the first time we should concentrate our attention on developing particular international recommendations for universities. These recommendations should contain information on programs of study and curricula developed to train highly qualified professionals. I would underline that I am speaking about recommendations, not demands or requirements.

The recommendations created by the GCHERA for programs of study and curricula should include the main achievements of the humankind both in the field of science and technology, and the field of human sciences. We need to pay attention to the last ones to realize the panhuman values of humanism and democracy. This issue demands a lot of discussion. So, I propose to start this work right now. In a year we can meet together for separate international conferences and discuss the developed materials and review the general recommendations.

Implementation of the created recommendations will be realized in each institution and each country that chooses to do so. The degree of the recommendations and implementation in each university could have a great importance for future development of international civil accreditation system for professional training and play an important role in diploma recognition on the international level.

I have this book titled "The Curricula and Courses for Undergraduate and Graduate Students of NAUU." You can find the curricula and courses in English on the Web site of our university: <http://www.nauu.kiev .ua>. Iowa and Louisiana State Universities officially recognize these curricula and courses as acceptable in meeting their requirements. I do hope, that in two years we will have a new book like this with a title "The World Recommendations for Curricula and Courses at Agricultural Universities." I think, our attention should also be paid to the ideas of some of our colleagues who proposed to organize within the frameworks of the GCHERA self-sustained structures to realize our plans in organizing student and young researcher exchanges and their training in leading universities; developing and editing up-to-date teaching materials; holding scientific and methodological conferences; holding exhibitions on education and research technologies for young scientists and student competition. We should then award the best of them with GCHERA prizes.

Once again, I want to stress that the important direction of the GCHERA future activity should be extending its creative links with such well-known international organizations as FAO, UNESCO, The World Bank, WTO, EU, USAID, USIA, other international foundations, institutions, and sponsors who have the same purposes as we have. We really look forward to collaboration through developing and realizing a number of common global projects listed below.

Tentative Directions for GCHERA Collaboration with The World Bank, FAO, UNESCO, European Union, other International Organizations and Foundations:

Developing global norms and criteria for higher agricultural education on the main majors in the field of agriculture, forestry, fishery, and veterinary medicine;

Establishing the global network of programs of study and courses for distance higher agricultural education;

Quality and safety of agricultural products, including GMO;

International standards and certification of agricultural products;

Agricultural industry and problem of greenhouse effect in atmosphere;

Advertising of the universities' up-to-date achievements in training and research technologies through organizing exhibitions of educational equipment, educational technologies, including teaching and studying materials, and editing a periodical GCHERA journal on education and research for agriculture; and

Organizing international young researchers and students competitions.

On behalf of the GCHERA, we can provide these organizations and individuals with our support in rapid dissemination of information about their plans, missions, and achievements, as well as assist them in setting business contacts with future possible partners in different countries.

For closing my speech, again and again, I am pleased to express my deep gratitude to our first President, Dr. Martin Jischke, the members of Executive Committee, leaders and members of the working groups, the GCHERA Secretariat, and especially Dr. David Acker, Dr. David Sammons, Ms. Sally Ashlock, and Dr. Victor Udin for your collaboration and excellent relationships.

As Dr. Jischke has already said, we propose to have the next GCHERA's conference in Kiev, the capital of Ukraine. This city is more than 1,000 years old. Kiev is one of the most beautiful cities in the world, and I am sure that the participants of our next conference will enjoy it. I invite all of you to take an active part in realization of the bylaws and goals of our consortium, and I look forward to seeing you again!

Thank you.

Conference Program

Global Consortium of Higher Education and Research for Agriculture and Food Systems in the 21st Century

July 12–14, 2001

Renaissance Stanford Court Hotel · San Francisco, California, USA

A registration and general information table will be located in the foyer throughout the conference.

All general sessions on Thursday and Friday will be held in the Stanford Ballroom.

Thursday, July 12

0830 – 0900

Welcome from the President of the Global Consortium of Higher Education and Research for Agriculture
Dr. Martin C. Jischke, President
Global Consortium of Higher Education and Research for Agriculture
President, Purdue University
Indiana, USA

Welcome to California and Overview of University of California, Davis
Dr. William Lacy, Vice Provost
University Outreach and International Programs
University of California, Davis
California, USA

0900 – 1000

Opening Keynote Address
Mr. M. Peter McPherson, J.D., President
Michigan State University
Michigan, USA

1000 – 1030

Poster Session and Refreshments *(Poster titles are listed in Appendix III)*

▶ **Theme I - New Science in a New Century: Agricultural Research, Life Sciences and Information Technology**

1030 – 1130

Chair:
Dr. Cees M. Karssen, Former Rector, Wageningen University and Research Center, The Netherlands; and President, University Consortium for Agricultural and Related Science in Europe (ICA)

Speaker:
Dr. Paul Ming-Hsien Sun, Vice Chair of Board
Asian Vegetable Research and Development Center
Taiwan

Discussant Panel:
Dr. Adel El-Beltagy, Director General, International Center for Agricultural Research in the Dry Areas (ICARDA), Syria

Dr. Harald von Witzke, Professor and Chair, Department of Agricultural Economics and Social Sciences, Humboldt-University of Berlin, Germany

Thursday, July 12, 2001 *Continued*

1130 – 1230 **Speaker:**
Dr. Roger N. Beachy, President
Danforth Plant Science Center
Missouri, USA

Discussant Panel:
Dr. Laurent Martens, Chair, Agricultural Economics, Gent University, Belgium

Dr. Hans Herren, Director General, International Center for Insect Physiology and Ecology (ICIPE), Kenya

1230 – 1430 **Lunch**

▶ **Theme II-The Changing Nature of Food Systems and the University Response**

1430 – 1530 **Chair:**
Dr. Jia-an Cheng, Vice President, Zhejiang University, China

Speaker:
Dr. Elaine R. Wedral, President
Nestlé Research and Development Centers
Connecticut, USA

Discussant Panel:
Dr. Benjamin Figueroa, Director General, Colegio de Postgraduados Agrícola, Mexico

Dr. Bent Schmidt-Nielsen, Rector, Royal Veterinary and Agricultural University, Denmark

1530 – 1600 **Break**

1600 – 1700 **Speaker:**
Dr. Robert L. Thompson, Director
Rural Development Department
The World Bank
Washington, DC, USA

Discussant Panel:
Dr. Muhammad Shatanawi, Dean, Faculty of Agriculture, University of Jordan, Jordan

Dr. Colien Hefferan, Administrator, United States Department of Agriculture, Cooperative States Research, Education and Extension Service (USDA/CSREES), Washington, D.C., USA

1700 – 1830 **Free Time**

1830 – 1930 **Reception**

Friday, July 13

▶ **Theme III - Agricultural Curricula for the 21st Century**

0830 – 0945 **Chair:**
Dr. C. Peter Magrath, President, National Association of State Universities and Land-Grant Colleges (NASULGC), Washington, D.C., USA

Speaker:
Dr. S. Kannaiyan, Vice Chancellor
Tamil Nadu Agricultural University
India

Discussant Panel:
Dr. John Ssebuwufu, Vice Chancellor, Makerere University, Uganda

Dr. H. Dean Sutphin, Associate Dean, Academic Programs, Cornell University, USA

0945 – 1015 **Break**

1015 – 1130 **Speaker:**
Dr. Maris O'Rourke, Former Secretary for Education
and Chief Executive of the Ministry of Education
New Zealand

Discussant Panel:
Dr. Lavinia Gasperini, Senior Education Officer, Food and Agriculture Organization of the United Nations (FAO), Italy

Dr. Rodolfo Undan, President, Central Luzon State University, Philippines

1130 – 1330 **Lunch**

▶ **Theme IV - Organizing the University of the Future**

1330 –1430 **Chair:**
Dr. Keith Andrews, Director General, Escuela Agrícola Panamericana Zamorano, Honduras

Speaker:
Dr. Mabel Imbuga, Dean, Faculty of Science
Jomo Kenyatta University of Agriculture and Technology
Kenya

Discussant Panel:
Dr. Robert Linder, Executive Dean, Faculty of Agriculture, University of Western Australia, Australia

Dr. José Zaglul, President, EARTH University, Costa Rica

1430 – 1530 **Speaker:**
Dr. Richard M. Foster, Vice President for Programs
W.K. Kellogg Foundation
Michigan, USA

Discussant Panel:
Mensah Bonsu, Dean, School of Agriculture, University of Cape Coast, Ghana

Dr. Walter Armbruster, President, Farm Foundation, Illinois, USA

1530 – 1600 **Break**

Friday, July 13, 2001 *Continued*

1600 – 1700	**Summary and Next Steps** Dr. Martin C. Jischke, President Global Consortium of Higher Education and Research for Agriculture President, Purdue University Indiana, USA Dr. Dmytro Melnychuk, President-Elect Global Consortium of Higher Education and Research for Agriculture Rector, National Agricultural University Ukraine
1700 – 1900	**Free Time**
1900	**Banquet**

Saturday, July 14

0830 – 1000	**Workshops-Session I**
1000 – 1030	**Break**
1030 – 1200	**Workshops-Session II**

Workshop themes are listed in Appendix II.

Workshops

Global Consortium of Higher Education and Research for Agriculture and Food Systems in the 21st Century

Workshop/Roundtable Discussion Schedule for Saturday, July 14, 2001

Topic–Session I	Topic–Session II
* Educational Leadership *(Leader: Martin Jischke - USA)*	* Food Safety *(Leader: Roland Verhe - Belgium)*
* Distance Education/Virtual University *(Leader: Jim Grieshop - USA)*	* Information Technology *(Leader: Robert Mulley - Australia)*
Food Security/World Food Summit *Workshop Organized by Food and Agricultural Organization of the United Nations* *(Leader: Lavinia Gasperini - FAO, Italy)*	Student Exchange *(Leader: Marie Lummerzheim - France)*
* Cataloging Agricultural Programs and the Establishment of a Joint MBA *(Leaders: Dmytro Melnychuk - Ukraine and Herbert Stroebel - Germany)*	Outreach/Extension *(Leader: Michael McGirr - USA)*
World Agriculture Forum *(Leader: Vic Lechtenberg - USA)*	Executive Committee (new members meeting) *(Leader: Dmytro Melnychuk - Ukraine)*
National Association of State Universities and Land-Grant Colleges (NASULGC) Inter-University Conference on Agriculture Partnership *(Leader: Rodney Brown - USA)*	Links to Industry *(Leader: A.S. Prabhakar - India)*
	Strengthening African Universities African Development Bank *(Leaders: Onuma Okezie - USA and Boukary Savadogo - Cote d'Ivoire)*

* *Working Group formed at the Amsterdam conference in July 1999.*

Poster Session

Global Consortium of Higher Education and Research for Agriculture and Food Systems in the 21st Century

GCHERA Introduction

Sammons	Purdue University (USA)	GCHERA

Education *(Curriculum and Methodology)*

Gupta	Himachal Pradesh Agricultural University (India)	Teaching Program Reorganization of Curriculum in Agricultural Education
Taylor	EARTH College (Costa Rica)	EARTH College and the Salzburg Seminar

Education *(Organization, Leadership, and Administration)*

Crewe	University of Pretoria (South Africa)	Changes in the Agriculture Faculty
Ghoddusi/Koocheki	Ferdowsi University of Mashhad (Iran)	Higher Agricultural Education in Iran
Pekic	University of Belgrade (Serbia)	Overview of Agriculture Program
Prabhakar	University of Agricultural Sciences (India)	Problems and Prospects of Agricultural Education
Udin	National Agricultural University (Ukraine), Iowa State University (USA)	Survey of Agricultural Education Administrators ("Beyond the Deanship")

Distance Education

Namuth	University of Nebraska (USA)	Agricultural Technology Electronic Education Resources
Sutphin	Cornell University (USA)	The Global Seminar Project

Extension

Kalna-Dubinyuk	National Agricultural University (Ukraine)	Development of Extension System in Ukraine

Research and Education Linkages

Crawford	University of Nebraska (USA)	Collaborative Research Support Program (CRSP) Overview
Demment	University of California, Davis (USA)	Building African Scientific and Institutional Capacity Initiative (BASIC)

Global Research

Debelo	Ethiopian Agricultural Research Organization	Overview of Research Organization
El-Beltagy	International Center for Agricultural Research in the Dry Areas (ICARDA) (Syria)	Expert System for Irrigating Wheat in Egypt
Hossain	Asian Institute of Technology (Thailand)	Agricultural Research Goals for 21st Century

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Executive Committee Report

Second GCHERA Conference
San Francisco, California USA
July 11, 2001

Summary report presented by Martin C. Jischke, President of GCHERA to GCHERA membership on July 13, 2001 at closing plenary session of global conference:

I want to share with you a report of the Executive Committee of GCHERA to this conference. We met on Wednesday (July 11) before the conference began. We are happy to report officially that GCHERA currently has 387 members from 136 countries of the world and that this conference has over 200 participants from more than 50 nations. During the July 11 Executive Committee meeting we approved a number of items and I want to report on those.

1. We first approved the work of the Executive Committee, the President, and the Secretariat on fulfilling the bylaws of the consortium over the last two years. What we did was consistent with what we were allowed to do. The Executive Committee expressed gratitude to the President and I am grateful for that. It approved the decision of GCHERA's Executive Committee to inaugurate Dr. Dmytro Melnychuk, Rector of the National Agriculture University of Ukraine, as the new President of Gchera for the period 2001-2003 and it elected Dr. Jia-an Cheng, Vice President of Zhejiang University in China as the President-elect of GCHERA.
2. The Executive Committee expressed its gratitude to the many members of the organization who expressed their willingness to serve on the Executive Committee and selected six new members to that committee to broaden, geographically in particular, the participation and representation on the Executive Committee. Those who were selected were Dr. J.B. Chowdhury, Vice Chancellor of G.B. Pant University of Agriculture and Technology in India; Dr. Stanley Johnson, Vice Provost for Extension at Iowa State University in the United States; Dr. Yurii Lachuga, Head of the Department of Staff Policy and Education in the Ministry of Agriculture and Food of Russia; Dr. Ernst Lindemann, Dean of the Faculty of Agriculture and Horticulture at Humboldt University of Berlin, Germany; Dr. Henry Thairu, Deputy Vice Chancellor (Academic) of Jomo Kenyatta University of Agriculture and Technology in Nairobi, Kenya; and Dr. Jose´ Zaglul, President of E.A.R.T.H. University of Costa Rica.
3. It instructed the GCHERA Secretariat at Purdue University to transfer all official documents to the new Secretariat, headed by Dr. Maksym Melnychuk at the National Agricultural University of Kiev, so that he can begin his new responsibility.
4. It approved a recommendation to establish a new structure for fees for GCHERA membership keeping the individual membership at the current US$25 level and increasing that for institutions to US$100 for those from developing countries and countries in transition and US$250 for institutional membership for developed countries.
5. It identified some areas of emphasis for the work of the new consortium President and the Executive Committee over the next two years as follows: to develop recommendations for global curricula in programs of study; to provide support to agricultural universities that are undergoing reforms; to facilitate international cooperation to promote the best teaching and research as well as advancing scientific knowledge through research; to facilitate cooperation to permit practical training of scientists and students at the leading educational and research centers of the world; and to assist international governmental and non-governmental organizations in promoting the ideas of humanism, democratization, and justice.
6. The Executive Committee proposed that the new president, Dr. Melnychuk, consider the task of approaching the World Bank, FAO, UNESCO and others in order to promote the ideas of this consortium and to seek resources to finance its activities.
7. It decided to hold the next conference of GCHERA in the fall of 2003. The Executive Committee has authorized Dr. Melnychuk to organize the next GCHERA conference at the venue of his choice and he informed the committee that he is pleased to invite all GCHERA members and other interested parties to the next conference in Kiev, Ukraine in the fall of 2003.

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Speaker Biographies

Global Consortium of Higher Education and Research for Agriculture (GCHERA)

Dr. Roger N. Beachy

Dr. Roger N. Beachy, internationally known for his work in virus resistant plants, is the founding president of the Donald Danforth Plant Science Center, St. Louis, Missouri. Prior to assuming this post, he was from 1991 to 1998 head of the Division of Plant Biology at the Scripps Research Institute in La Jolla, California, where he was also co-director of the International Laboratory for Tropical Agricultural Biotechnology.

From 1978 to 1991 Dr. Beachy was professor and head of the Center for Plant Science and Biotechnology at Washington University in St. Louis. His work there, in collaboration with Monsanto Company, led to the development of the world's first genetically-altered, virus-resistant food crop, a variety of tomato. His technique has been replicated by others to produce many types of virus resistant plants. He has edited or contributed to 50 book articles, and his work has produced more than 190 journal publications.

Dr. Beachy has received a number of prestigious awards including the Wolf Prize in Agriculture in 2001, the D. Robert Hoagland Award, and the William D. Phillips Technology Advancement Award in 1995, and election to the U.S. National Academy of Sciences in 1997. He earned his B.A. in biology from Goshen College, Goshen, Indiana, and his Ph.D. in plant pathology from Michigan State University.

The Donald Danforth Plant Science Center is a not-for-profit, fully independent institution that conducts and facilitates world class, interdisciplinary research in genetics, chemistry, cell biology, biochemistry, computational genomics, and structural biology. The center is a unique partnership of the Missouri Botanical Garden, Monsanto Company, Purdue University, the University of Illinois at Urbana-Champaign, the University of Missouri-Columbia, Washington University, and the St. Louis-based Danforth Foundation.

Dr. Richard M. Foster

Dr. Richard M. Foster is vice president for programs at the W.K. Kellogg Foundation of Battle Creek, Michigan. Specific programming initiatives for which he is responsible include Integrated Farming Systems, Food Systems Professions Education, Managing Information with Rural America, Mid-South Delta Initiative, People and Land, and the Kellogg National Leadership Program.

Dr. Foster joined the foundation in 1991 as a visiting professional while on sabbatical leave from the University of Nebraska where he served as a professor of agricultural education. Prior to joining the foundation, he had taught at Iowa State University and the University of Idaho, and worked at the School of Agriculture for the Humid Tropics (E.A.R.T.H.) in Costa Rica. He received the E.B. Knight Award from the National Association of Colleges and Teachers of Agriculture as well as the Distinguished Teaching Award and Outstanding Young Professor awards from the University of Nebraska. He received his undergraduate and graduate degrees in agricultural education from Iowa State University.

The W.K. Kellogg Foundation is a nonprofit organization whose main goal is to help people help themselves through the practical application of knowledge and resources to improve their quality of life and that of future generations. The foundation focuses on building the capacity of individuals, communities, and institutions to solve their own problems.

Dr. Mabel Imbuga

Dr. Mabel Imbuga is dean of the faculty of science and professor of biochemistry at the Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya. She is chairperson of African Women in Science and Engineering, an organization that collaborates with International Women in Science and Engineering (IWISE), American Association for the Advancement of Science (AAAS), and the Association of American Colleges and Universities (AACU).

Dr. Imbuga's research includes studies of the use of natural products in the management of pests and the control of tropical diseases. She completed her undergraduate and post-graduate studies at the University of Nairobi. Prior to joining the faculty at Jomo Kenyatta University in 1995, she was a member of the staff of the International Center of Insect Physiology and Ecology (ICIPE), which is also located in Nairobi.

Dr. Martin C. Jischke

Dr. Martin Jischke became president of Purdue University in West Lafayette, Indiana, in August 2000. Previously, he served nine years as president of Iowa State University. Under Dr. Jischke's leadership, Iowa State University enjoyed a period of substantial growth and development. The quality and size of the faculty, student body, staff, and administrative leadership were improved. Research and economic development programs were expanded.

Dr. Jischke went to Iowa State University from the University of Missouri, Rolla, where he was chancellor from 1986 to 1991. Prior to his tenure at the University of Missouri, he was dean of the College of Engineering and interim president of the University of Oklahoma. He is the author or co-author of 31 archival journal publications and 21 major technical reports. He has served as a White House Fellow and Special Assistant to the Secretary of Transportation. He was the 1998 chair of the National Association of State Universities and Land-Grant Colleges (NASULGC) board of directors and is a member of the board of the American Council on Education and the National Merit Scholarship Corporation. He has received the Centennial Medallion from the American Society of Engineering Education and is a fellow of the American Institute of Aeronautics and Astronautics and the American Association for the Advancement of Science. Dr. Jischke is a member of the Founding and Organizing Committees of GCHERA. He earned his B.S. in physics from the Illinois Institute of Technology and his graduate degrees in aeronautics and astronautics from the Massachusetts Institute of Technology.

Founded in 1869, Purdue University is a public, land-grant research university with an international reputation for academic excellence. Its programs include engineering, agriculture, science, veterinary medicine, management, technology, consumer and family sciences, education, liberal arts, pharmacy, nursing, and health sciences. Purdue's all campus enrollment exceeds 67,000, 12 percent of whom are graduate students. Its enrollment of international students is the largest of any U.S. public educational institution. Faculty and staff exceed 14,000, and the annual budget is more than $1.1 billion.

Dr. S. Kannaiyan

Dr. S. Kannaiyan, an internationally known microbiologist, is vice-chancellor of Tamil Nadu Agricultural University (TNAU), Coimbatore, India. Prior to assuming his present post in 1999, he was dean of the Faculty of Agriculture. Actively involved in rice research for the past 30 years Dr. Kannaiyan has published more than 400 scientific papers and 22 books. He continues to teach post-graduate students in agricultural microbiology and biotechnology.

Dr. Kannaiyan has received several awards including the prestigious Hari Om Ashram National Award by the Indian Council of Agricultural Research (1997), World Intellectual Award (1993), and TNAU Best Research Scientist Award (1995). He is Indian coordinator, Academic Link Research Programme, Agricultural Biotechnology, British Council, England, and joint coordinator of the International Network on Soil Fertility and Sustainable Rice Farming with the International Rice Research Institute, the Philippines. His work has taken him to more than 43 countries.

Dr. Kannaiyan received his undergraduate and graduate degrees from Annamalai University, India, and held post doctoral fellowships at the C.F. Kettering Research Laboratory in Ohio, USA, and at Kings College, University of London, U.K.

TNAU is an autonomous institution that conducts research and offers undergraduate and post-graduate educational programs in agriculture, horticulture,

agricultural engineering, forestry, and home science. The university also carries out extension education activities through its technology transfer programs. Although the university was established in 1971, the genesis of agricultural education in the state dates back to 1868.

Dr. William B. Lacy

Dr. William B. Lacy is the vice provost for University Outreach and International Programs at the University of California-Davis and professor of sociology in the Department of Human and Community Development. As vice provost he provides leadership for the coordination of all aspects of the campus' expanding outreach and international initiatives.

Dr. Lacy received his B.S. in organizational behavior and industrial relations from Cornell University, his M.A. in administration in higher education from Colgate University, and his Ph.D. in sociology from the University of Michigan. He was professor of sociology at the University of Kentucky from 1974 to 1989. From 1989 to 1994, Dr. Lacy was the assistant dean for Research in the College of Agricultural Sciences at Pennsylvania State University.

Then for four years prior to his arrival at the University of California-Davis in 1998, Dr. Lacy was the director of Cornell Cooperative Extension and associate dean of the Colleges of Agriculture and Life Sciences, and Human Ecology at Cornell University.

Dr. Lacy has authored/co-authored over 60 journal articles and book chapters on education, science policy, agricultural research and extension, biotechnology, and biodiversity, and co-authored/co-edited six books. He is a fellow of the American Association for the Advancement of Science; 1990 recipient of the Excellence in Research Award from the Rural Sociological Society; the 1992-1993 President of the Agriculture, Food and Human Values Society; and 1999 president of the Rural Sociological Society.

Mr. M. Peter McPherson

Mr. Peter McPherson brings to GCHERA the insights of an enlightened public servant and an educator who is also distinguished for his work in the legal and banking professions. He is president of Michigan State University (MSU), East Lansing, Michigan. Throughout his career he has sustained a steadfast interest and constructive involvement in matters international.

As a public servant, Mr. McPherson has held several major governmental posts in Washington, D.C. After processing legal work with the Internal Revenue Service for six years he, in 1975, was named special assistant to President Ford. Two years later he became head of the Washington, D.C. office of a large law firm. Then in 1981, Mr. McPherson was appointed administrator of the U.S. Agency for International Development (USAID) and chairman of the board for the U.S. governmental agency that provides political risk insurance coverage for U.S. investors in developing countries (OPIC). He administered a budget of $6 to $7 billion a year with missions in some 70 countries during the six years that he headed USAID.

Mr. McPherson returned to the private sector as group executive vice president of the Bank of America after serving two years, 1987-89, as deputy secretary of the U.S. Treasury Department. As vice president of the Bank of America, his responsibilities included work with developing countries including the restructuring of troubled debts.

It was from his Bank of America post that in 1993 Mr. McPherson returned to his home state and his alma mater Michigan State University, where he continues his dedication to worldwide agriculture and economic development.

Founded in 1855, Michigan State University has a rich history of providing educational opportunities to students of diverse interests, abilities, and backgrounds. More than 34,000 undergraduate and 7,750 graduate students currently pursue degrees at this accessible land-grant institution. Michigan State University's undergraduate degree-granting colleges include: agriculture and natural resources, arts and letters, business, communication arts and sciences, education, engineering, human ecology, natural science, nursing, social sciences, and veterinary medicine.

Dr. Dmytro O. Melnychuk

Dr. Dmytro O. Melnychuk is rector and professor at the National Agriculture University (NAUU) in Kiev, Ukraine. Dr. Melnychuk is an academician of the National Academy of Sciences of Ukraine and Ukrainian Academy of Agricultural Sciences. He holds a

doctorate of biological science, and is a laureate of the State Prize in Science and Technology. He is an internationally prominent scientist in the field of biochemistry where he researches the molecular mechanisms of metabolism regulation in human and animal organisms. He is the president of the Ukrainian Biochemistry Society and president of the Ukrainian Agricultural Universities' (Academies, Institutes) Council of Rectors. He received the honorary title of "World Professor" from Iowa State University in 1996. He is a member of the Founding and Organizing Committees of the Global Consortium of Higher Education and Research for Agriculture (GCHERA) and is president-elect of the organization. He will serve as GCHERA's president for the term 2001-2003.

National Agriculture University is the premier agricultural university in Ukraine, training more than 18,000 students in agrobiology, agroecology, agribusiness, mechanization, forestry and fishery, agroengineering, veterinary medicine, land management, and plant protection. The institution contains six regional colleges and technical schools, two research stations, and two training/research farms where it teaches agriculture, forestry, and veterinary medicine. The University carries out broad-scale international relationships with partner universities and companies, conducts scientific research work, and develops experts for the agricultural sector.

Dr. Maris O'Rourke

Dr. Maris O'Rourke, now a private consultant based in her native New Zealand, was from 1995 to 2000 director of education for the World Bank. Prior to that she was the first secretary of education and chief executive of New Zealand Ministry of Education with the responsibility of managing a budget of $4.3 billion. She is one of the architects and prime implementers of New Zealand's successful program of education reforms.

In her World Bank post, Dr. O'Rourke headed the group of 300 plus professionals who are members of the Human Development Network. The Bank's Education Sector Strategy was produced under her leadership, and many new external partnerships were set up with key agencies such as UNICEF, UNESCO, OECD, UNDP, USAID, and NGO groups.

Dr. O'Rourke began her working life as an apprentice engineer and worked for a number of years with engineering companies in a range of different countries. After beginning a family she attended the University of Auckland part-time. There, while also continuing to work outside of her home, she gained her undergraduate and post-graduate degrees, professional qualifications as a teacher, and became a registered psychologist. Her academic, research, and published work is focused on developmental psychology, behavioral analysis, teaching, and learning.

In recognition of her work Dr. O'Rourke has been awarded the New Zealand Commemoration Medal (1990), New Zealand Women's Suffrage Medal (1993) and was named a fellow of the New Zealand Institute of Management (1994). She has well-developed international networks and demonstrated ability to coordinate projects, disseminate information, and bring diverse groups to a consensus.

Dr. Paul M.H. Sun

Dr. Paul Ming-Hsien Sun is chairman of the board of the Taiwan Grains and Feeds Development Foundation (GFDF) and vice chair of the board of the Asian Vegetable Research and Development Center (AVRDC). He is a member of the board of the Central Bank, advisor to the Council of Agriculture, and managing director of the Rural Development Foundation.

Dr. Sun rose to national prominence as chief of the Plant Industry Division of the Chinese-American Joint Commission on Rural Reconstruction (JCRR). In this post, he was responsible for research and development related to crop improvement and agricultural technology throughout Taiwan. In 1988 he became commissioner of the Taiwan Provincial Department of Agriculture and Forestry. From 1996 until 2000, he was the national policy advisor to the president of Taiwan.

For many years, Dr. Sun, whose Ph.D. degree is in plant pathology, maintained a professorship at the National Chung Hsing University. During this tenure as deputy director general of AVRDC, he initiated cropping systems research that subsequently resulted in the formation of a research network throughout Taiwan.

Through his academic training, research leadership, and broad involvement in the formulation of national policies, Dr. Sun has made major contributions to the modernization of Taiwan's agriculture. He has also served the global community, especially through his years of leadership in the international agricultural research center, AVRDC.

Dr. Sun conducted his undergraduate studies at the National Taiwan University and obtained his graduate degrees at the University of Minnesota and Purdue University.

Dr. Robert L. Thompson

Dr. Robert L. Thompson, educator, developer, and public servant, has lectured, consulted or conducted research in more than 80 countries worldwide. He came to his current position of director of rural development of the World Bank from his academic background as an agricultural economist. In the course of his undergraduate work at Cornell University and graduate studies at Purdue University, Dr. Thompson completed long-term assignments in Denmark, Laos, and Brazil.

For a decade as a Purdue University faculty member, Professor Thompson focused on agricultural trade, public policy, and development. He moved to Washington, D.C. in 1983 to become senior staff economist on the President's Council of Economic Advisors. Two years later, Dr. Thompson was named assistant secretary of the U.S. Department of Agriculture. In 1987 he moved back to Purdue University where for six years he was dean of the School of Agriculture. Then from 1993 to 1998, Thompson was president and chief executive officer of Winrock International Institution for Agricultural Development. Winrock carries out projects in some 40 countries; these projects are designed to help reduce poverty and hunger by increasing agricultural productivity and rural employment while protecting the quality of the environment.

Dr. Thompson is a fellow of the American Agricultural Economics Association and the American Association for the Advancement of Science and a foreign member of the Royal Swedish Academy of Agriculture and Forestry and of the Ukrainian Academy of Agriculture Sciences. He was raised on a dairy farm in northern New York and is married to the former Karen Hansen of the Danish island of Bornholm.

The World Bank Group is the world's largest provider of development assistance with wide-ranging programs that help support research, education, and the strengthening of institutions serving rural people.

Dr. Elaine R. Wedral

Dr. Elaine Wedral is president of Nestlé Research and Development Center, Inc., the North American research arm of Nestlé S.A., the world's largest food company. She heads a scientific team that develops new technologies and products for retail and specialty markets worldwide. Under her leadership, the research and development programs of Libby, Beech-Nut, Carnation, and Nestlé were consolidated into one coordinated function for Nestlé in North America.

Dr. Wedral began her professional career as a chemist at Campbell Soup Company and has since held positions as head of Product Safety and Nutrition Service; vice president Technical Services, Libby, McNeil and Libby; vice president, R&D Westreco, Inc.; and senior vice president, Carnation/Nestlé R&D.

Dr. Wedral holds over 26 patents in food science and chemistry. She has served on the advisory boards of the National Academy of Science Research Council for Math and Science Education and of Cornell, Rutgers, and Teikyo Post Universities. Under her leadership and in conjunction with her international colleagues, an array of nutritional and clinical products has been developed. These include Carnation infant formulas, nutrition supplements, and specialty products for pediatric and geriatric patients. Her vision led Nestlé to become a major corporate sponsor of the National Eldercare Institute on Nutrition.

Dr. Wedral received both her B.S. and her honorary doctorate of agriculture degrees from Purdue University and her Ph.D. in Food Chemistry and Microbiology from Cornell University. She was honored as "Woman of the Year" by the prestigious organization Women in Food, Flavor, and Fragrances in Commerce (1991), and has been awarded distinguished recognition and honorary degrees from several universities.

Nestlé S.A., an internationally recognized food company with some 500 production facilities in 70 countries, is headquartered in Vevey, Switzerland.

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